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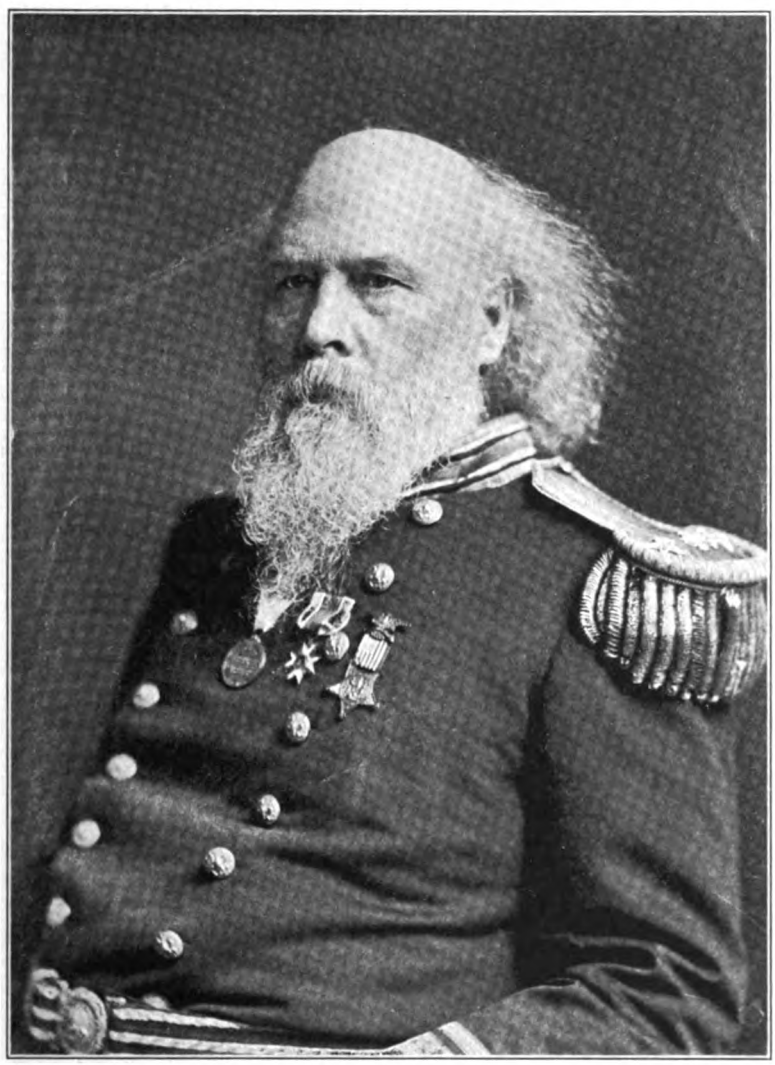
Epochs in Marine Engineering

A distinguished body of engineers gathered at the headquarters of the American Society of Mechanical Engineers, No. 12 West 31st street, New York, on Jan. 31 to listen to Rear Admiral George Wallace Melville, formerly engineer-in-chief of the United States navy, who gave a lecture upon "Epochs in Marine Engineering." Admiral Melville spoke without notes but with great cohesion and lucidity, pointing out step by step the various changes which have occurred in the science of marine engineering. Admiral Melville said:



REAR ADMIRAL GEORGE WALLACE MELVILLE.

To attempt to cover the history of marine engineering in a lecture which ought not to last much longer than an hour would result in little more than a mere chronology and could not possibly be interesting. It seems much better, therefore, to give some consideration to the various periods or epochs in the history considered with reference to the special inventions or changes which have characterized them. Many of these changes are clear examples of evolutions and others are instances of the adaptation of land practice to marine use, but they all serve to show the constant progress which has taken place.

The first marine engineering in the modern sense was the adaptation of the steam engine as already in familiar use on shore to a modification of the centuries old method of mercantile propulsion, the oar. I believe some attempts were actually made to adapt the steam engine to a series of oars, which would have meant something like a mechanical trireme; but of course the trained mechanical sense soon saw that the collection of the oars in a revolving wheel was the correct solution. As oars had been used on both sides, so it was natural at first that the paddle wheels should be on both sides. A center wheel was also tried, but it is interesting to remark that practically about the same time that the sidewheels were used on the seaboard, the first marine engine was the shore engine modified to suit the circumstances and thus on the seaboard the engine was designed and worked with what we now consider an exceedingly low pressure. On the western rivers where the change has been made in the location of the wheel, there was also the

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additional change of dispensing with the condenser and using very much higher pressures. It was doubtless due to this fact that the first noncondensing engines really carried a very high pressure—that the term "high pressure" in the early days meant non-condensing. The reason for the difference is of course very clear; the western rivers are very shallow and it was necessary to make the machinery as light as possible; on the seaboard and the rivers of that section there was deep water and the vessels had displacement enough to permit of heavy machinery.

Ordinarily the history of this olden time could have only an antiquarian interest for us, but we are usually fortunate in still having with us in the active practice of his profession an engineer who saw the first commercially successful steamboat, the Clermont, so that through our "grand old man of engineering," Mr. Charles H. Haswell, we still have a living connection with that earlier time. One of my former assistants some years ago contributed a series of articles to one of the engineering magazines and has given some data as to the performance of the Fulton, the first American steam man-of-war, whose machinery was designed by Mr. Haswell, who was also her first chief engineer. An extract from the Fulton's steam log for January, 1838, shows that the maximum steam pressure was eleven pounds, the vacuum 24 in. and the maximum revolutions per minute 18.

THE SCREW PROPELLER.

As time passed on and experience was gained, there was naturally an improvement in workmanship and design and a moderate increase in steam pressure, but about 1836 the screw propeller was brought forward for driving large vessels. This was not the first application of the screw propeller, which had been used successfully on a small steamer or launch about 68 ft. long as early as 1804 by Col. John Stevens, the grandfather of Col. Edwin A. Stevens, who is now so active in marine work, and the father of Robert L. Stevens, who was the most famous of the name for his work in connection with marine engineering. It is to be noted that this date is prior to that of the building of the Fulton, but naturally, in the first steam war vessel, it was not considered desirable to do anything of an experimental nature, a condition which has obtained to some extent ever since and probably always will. It was about ten years later that the propeller began to come into general use and entirely displaced the paddle wheel for ocean-going steamers. The reason for this change is easy to see on a little consideration. On a long ocean voyage the change in displacement is due almost entirely to the consumption of fuel. In the case of the propeller this makes practically no difference in its immersion or in its efficiency, while in the case of the paddle wheel the immersion of the floats would be changed, with a diminution of efficiency. Further than this, the paddle boxes offered very great resistance to strong head winds and also brought severe stresses on the ship, due to rolling in heavy seas, the propeller not being affected by either of these last two causes. Today for work in deep water the screw, of course, is the only propeller; but for river work, particularly in shallow rivers, the paddle wheel is still used. Efforts have been made, and some of them exceedingly ingenious, to adapt the propeller to use in shallow water, and a certain amount of success has attended the efforts of such brilliant engineers as Yarrow and Thornycroft, not to mention our own Mr. Charles Ward, who has done some work in this connection. The fact remains, however, that damage by sand bars, snags, etc., may easily render screw machinery inoperative, while as expressed by an engineer who had designed many western river boats, "any weed butcher can repair a stern wheel."

Probably fully as much has been done to improve the design of propellers, as time has gone on, as any other part of marine machinery. In the early days the rule for propeller design were exceedingly crude, but with the slow engine speeds which then obtained the effects were not so noticeable. As engine speeds increased, however, it was seen that these old rules were utterly inadmissible. There is no good excuse, however, for progress having been so long delayed, for the designs still remained too crude even after Isherwood's famous Mare island experiments in 1868. Probably one of the great troubles with screw propeller design at the beginning was the mistake made in considering the action of the screw as analogous to that of a bolt working in a nut, from which it was inferred that the smaller the slip the greater the efficiency. As a matter of fact, a screw propeller is really a pump for driving a mass of water astern, the reaction from which drives the vessel ahead. When this had once been realized, it was seen that there must be a certain amount of slip and that under proper conditions there could be a relatively large slip and still high efficiency.

Multiple screws were used as early as our civil war on some vessels known as "tin-clads" on the Mississippi, their adoption being necessitated by the shallow draught. Twin screws were first used in war vessels where the necessity for keeping the machinery below the deck would not allow of all the power being conveniently used on a single shaft, but the great advantage they possess of security against total disablement and for maneuvering soon made them the rule for all naval vessels large enough to admit of them. They were much longer in coming in the merchant service where the limitations of machinery do not obtain; but since the era of the very large trans-Atlantic steamers, beginning with the Paris and New York and the Teutonic and Majestic, all very large vessels have been built with twin screws.

In the navies of France and Germany, the triple screws have been used to a considerable extent, and I used them myself in our own fast cruisers Columbia and Minneapolis. My own belief is that they have decided merit for vessels using above 10,000 horse power. This view, however, was not shared by my board of colleagues in the navy department, so that their marked success in the two vessels named was not allowed to be repeated in later designs.

With the advent of the steam turbine as a prime mover in ships, multiple screws have again come to the front, this time on account of the extremely high speed of rotation of the shafts. The Turbinia, the first vessel of this kind, had three shafts with three propellers on each; and the destroyers Viper and Cobra had four shafts with two propellers on each. The merchant vessels, beginning with the King Edward, have been fitted with three shafts.

Before leaving the propeller, I may mention, in connection with the improvements in its design, the care that is now taken to avoid needless friction by making the hub spherical with a conical tail piece, and by putting covering plates over the bolts securing the plates to the hub so as to continue the outline of the sphere or conoid.

THE SURFACE CONDENSER.

Up to about 1860 the jet condenser was the one usually employed on board ship, which meant, of course, that the boilers were constantly fed with salt water; and this, in turn, meant the deposition of great quantities of sulphate of lime scale on the heating surface. With the low pressure then prevalent this did not greatly affect the economy of the boilers, except that as "blowing off" to keep the density of the water down was a continuous practice, there was a certain loss of heat, and of course there was the necessity for frequent scaling of the heating surfaces. However, they were effectually protected against corrosion. About 1850 the use of surface condensation became general, and as this greatly reduced the amount of scale formed, it was practicable and safe to increase steam

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pressures, which accordingly resulted with a consequent reduction in the weight of machinery per unit of power.

An accompaniment of the introduction of surface condensation, which was at first supposed to be a result of it, but which as a matter of fact was not, was a tremendous increase in the corrosion of the boilers and shortening of their life. This was especially noticeable in the tubes which, as the thinnest part of the boilers, gave out first. All sorts of theories were advanced to account for it, some of which we can now see to have been utterly ridiculous. Probably one of the most fanciful was that which regarded the boiler and condenser as forming a gigantic galvanic battery, the copper condenser tubes forming one pole and the boiler the other. The real facts were developed as a result of the investigation by the admiralty committee on boilers in the 70's which showed that boiler corrosion was simply rusting and had been due to gross but unintentional neglect. It had been a very common practice, particularly in naval boilers, when they were not in use, to blow out the water, and take off the manhole plates "to let them air." It was this "airing" which caused the corrosion. Now when boilers are laid up, they are filled with water which is made slightly alkaline, and this effectually prevents corrosion.

THE CYLINDRICAL BOILER.

The early boilers in sea-going vessels were of what has been called the "box" type; that is, the boiler was a cubical box with a thin shell, the real strength being given by braces running in three directions. When surface condensation had made higher pressures possible, it was soon found that the multiplicity of braces, as pressures were increased, made an impossible condition of affairs, and this led to the design of the cylindrical boiler whose shell was self-bracing and left the only braces, those needed for the heads and flat surfaces. This boiler so thoroughly met the conditions arising that it has remained the favorite even up to the present day. At one time an effort was made to save room by making the boiler elliptical, but this was soon found to be unsatisfactory and impracticable and was abandoned after only a few examples.

The earliest cylindrical boilers were single-ended with two furnaces, but with the advent of reliable mild steel the diameters were increased and the boiler was made double ended, with the upper ends rounded to save bracing, so that the largest cylindrical boilers today have as many as eight furnaces, four in each end in pairs; that is, the two furnaces at each end on the same side of a vertical diameter have a common combustion chamber. The saving in weight due to the double ended boiler is evident at once and also the reduction in the feeding apparatus required.

Notwithstanding the advent of the water-tube boiler which will be mentioned further on, and its practical pre-emption of naval practice, the cylindrical boiler still remains the favorite for the merchant service and has been used for pressures as high as 220 lbs., even in the largest sizes on such vessels as the Kaiser Wilhelm. The highest recorded pressure is 253 lbs. on the Inchdune.

THE COMPOUND ENGINE.

From a very early period steam had been used expansively in marine engines, and indeed sometimes to a ridiculous extent. Some engineers as late as the civil war hardly seemed to realize that there was any limit to expansion, although Isherwood's famous experiments on the Michigan in 1861 had demonstrated conclusively that, with low pressures, only a very moderate expansion is permissible, beyond which any further expansion is attended by an economic loss. As pressures increased it was natural and correct that a higher range of expansion should be used, and this made practicable the compound engine where the expansion occurs in two stages, the high pressure steam from the boiler being limited to a small cylinder from which, in turn, the steam of lower pressure is exhausted to a larger cylinder. As you all know, the compound engine was invented almost as early as Watt's separate condenser, Hornblower's patent dating back to 1771, and Wolff's patent for a two-cylinder engine dating back to 1804. With the low pressure prevalent at that time the compound engine was actually at a disadvantage compared with the simple one. When pressures had gotten up to about 60 lbs., however, the compound engine began to assert itself, the pioneer in that respect being John Elder of the firm of Randolph & Elder, which is now known as the Fairfield Engine Works. It is interesting to note that the Allan Line of steamers, which is now the pioneer in introducing the steam turbine for an ocean-going steamer, made the last scientific stand against the compound engine, going so far as to take duplicate vessels, and engine one with compound and the other with simple engines of the same power. The actual experience with these two vessels where the simple engine with the high ratio of expansion was constantly in trouble from breaking down, was a convincing proof that high ratios of expansion in a single cylinder was impracticable.

With the improved workmanship which had come by this time and with the improvement in materials, to which we shall refer in a moment, which came later, the compound engine advanced to a high state of perfection and for large powers the three cylinder type, with one high pressure and two low pressure cylinders, became a favorite for all large vessels. These engines were probably as fine specimens of marine engine designing as have ever been seen, and included some exceedingly ingenious valve gears designed to secure variable expansion and an equalization of work among the various cylinders. As we shall see later, the further advance relegated these beautiful mechanisms to the engineering museum.

THE ADVENT OF MILD STEEL.

It is probably difficult for the young men in our technical schools of today who are familiar almost entirely with mild steel and very little with wrought iron, to realize what a change came in engineering when the production of mild steel became a commercially reliable matter. When we look back at the way in which some of the vital elements of a big marine engine were made, we are almost inclined to wonder that the material was reliable at all. The difference between a large wrought iron shaft such as old Hughey Dougherty used to make at the Morgan Iron Works, and one of the mild steel shafts made at Bethlehem, is as great as could be imagined. Nearly the same is true of boiler plates. The young engineer of today would hardly know what was meant by a lamination or a "cold shut." The very method of manufacture made it necessary to use a large factor of safety in designing, with the result that the working stresses permissible were very low and the weight of machinery inordinately high. With the advent of mild steel and the introduction of careful and systematic testing, the designer had a material on which he could place absolute reliance so that the factor of safety could be greatly reduced. As a matter of fact the factor of safety has been reduced from 8 or 10 to 5, and sometimes as low as 4.5.

In looking back over my own experience, I do not see how we could possibly have built engines of the size and power now common with wrought iron for piston and connecting rods and shafting, and it is, of course, absolutely certain that we could not have built cylindrical boilers of today. The change began in the later 70's and had become almost complete by the middle of the 80's. We must not fail to notice in the change to steel the use of steel castings, which have displaced cast iron in many places with attendant great reduction in weight. The first use of steel castings was attended with considerable annoyance because it was unfortunately assumed, perhaps naturally that, barring the much greater shrinkage, it could be treated very much the same as cast iron,

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and it was consequently asserted with confidence that anything which had been made in cast iron could be made in cast steel. That is doubtless true today, but it certainly was not true ten or fifteen years ago, as I know to my personal sorrow, because designs which would have been considered simple in cast iron had to be entirely changed to meet the conditions then existing for steel castings.

It may be well to mention in this connection that about the same time that steel came into use displacing wrought iron, white metal for bearings and the stronger bronzes also came into use, thus giving the designer much better materials to work with and again reducing weights. We may also mention here the gradual displacement of copper for steam piping by steel pipes, owing to the fact that for the high pressures common at present copper pipes would have to be very thick, making it difficult to secure a sound joint, and also to the serious diminution of the strength of copper by the high temperature.

FORCED DRAFT.

Forced draft dates back of course to Stevens' Rocket, and its first use for marine purposes was by Mr. Robert L. Stevens on the Hudson river steamers in our own country prior to the civil war. During that war Mr. Isherwood built a number of gunboats which used forced draft, but it had fallen into disuse until about 1832 for naval vessels, when it was introduced into the English navy and still later was applied in the merchant service.

In naval machinery forced draft has been of the greatest possible importance, because it has reduced boiler weights probably almost one-half. In the navy the natural limitations as to space and weight prevent the use of forced draft with very much economy of fuel. It is obvious that if the rate of combustion is increased from 15 lbs. of coal per square foot of grate to 40 lbs., there ought to be an attendant increase of heating surface. In the merchant service, or at least in certain classes of vessels in that service, it is possible to do this, and in one of my annual reports I made a comparison between the boilers of the merchant vessel called the Iona and those of the Baltimore. In the Iona there were 75 ft. of heating surface for one of grate, while in the Baltimore the ratio was about 30 to 1; but had the Baltimore's boilers been designed with any such ratio, their weight would have been almost double the weight of all the machinery of that vessel as actually built.

Mr. James Howden has made a specialty of forced draft under economical conditions, heating the air before admission to the ash-pit; and his system is now in use on most of the large steamers, the aggregate horse power running up, I believe, to over a million.

HIGH ENGINE SPEEDS.

About the same time as the reintroduction of forced draft in naval vessels, the improved materials and workmanship made it possible to get higher rotational speeds, and as remarked earlier, the true conditions of propeller design being understood, there was a marked increase in the speed of rotation of the engines. Naval vessels, from the necessary limitations of keeping the vital parts of the machinery protected as far as possible, have always run faster than the engines of the merchant service, although this did not always mean that their piston speed was greater. The mistake is sometimes made of attributing lighter machinery to higher piston speeds, but unless this is accomplished by increasing the number of revolutions it will not produce that effect. In the early days, 60 or 70 revolutions per minute for what was then considered a large engine of 4,000 or 5,000 H. P., was about the limit, but in engines of as much as 8,000 H. P. for a single set one finds the revolutions today as high as 130. Of course it is not practicable to show to just what extent any one line of progress has reduced weights by comparing the machinery at periods wide apart, because the increase of steam pressure, increased rotational speeds, improved materials and better designing have all gone along together—but it is interesting to note that in the Warrior of 1861, with 22 lbs. boiler pressure and 54 revolutions, the horse power per ton of machinery was 6, while in the Minneapolis of 1891, with 165 lbs. pressure and 133 revolutions, the horse power per ton is 10.9. From a simple mechanical standpoint, contributing agencies to the high speeds are the much more perfect journals of the steel shafts and the superior white metals used for bearings, and the rigidity of the steel hull of the ship, as compared with the older conditions. The best makers now grind their bearings true to a mandrel which represents perfect alignment. In the old days all main shaft bearings were hollow for water circulation, which was generally needed, and there was usually provision for a spray of water on the crank pins. In the modern engines which have been well built and are carefully adjusted, there is no necessity for water, even at very high speeds under full power.

THE MULTIPLE EXPANSION ENGINE.

The change from the simple to the compound engine involved a certain amount of difficulty and opposition, but the lesson was then learned pretty thoroughly that the amount of expansion in a single cylinder was moderate. Consequently as steam pressures rose the leaders of the profession became convinced that to secure adequate economy a further stage of expansion was necessary, and this brought about the triple expansion engine, the credit for which is deservedly given to Dr. A. C. Kirk of the firm of R. Napier & Sons, of Glasgow, who first successfully used the triple expansion engine on the steamer Aberdeen. The adoption of the triple expansion engine was almost immediate, and after the success of the Aberdeen was demonstrated, all new engines of any size were built on that principle. It seemed a logical extension of this idea that with still further increase of pressure there should be the quadruple expansion engine, and a number of these have been built; but the advantage as compared with the triple expansion engine up to the point beyond which pressures have thus far not gone, does not seem to be clearly demonstrated, and a great many designers are adhering to the triple expansion engine with four cylinders, one high, one intermediate and two low pressures.

WATER TUBE BOILERS.

Like so many other details not only in marine engineering but in other lines of work features which are introduced in a practical way in recent times are found to have a comparatively ancient origin. This is true of the water tube boiler, which in its recent use dates from about 1880. The excavations at Pompeii have shown small boilers almost identical in construction with some of the best of our water tube boilers, although they were doubtless only used for a circulation of hot water.

The object of the water tube boiler is to reduce weights, give greater safety against explosion, greater rapidity of raising steam, and an increase of economy in the generation of steam. The various makes of water tube boilers are too numerous to mention, but they divide themselves into two broad, general classes; those with straight tubes of large diameters, say four inches; and those with curved tubes of small diameter, from an inch to an inch and a half. Probably no single boiler possesses all the merits which a perfect water tube boiler should have, and in nearly every case the attempt to secure certain advantages brings attendant disadvantages, and vice versa. The large straight tube boilers are not so light as the ones with small tubes; and it is more difficult to secure adequate economy, which is dependent largely upon skillful baffling. They do not permit of such rapid raising of steam from cold water as the smaller tube boilers. Because, like the Scotch boiler, they carry a large reserve supply of water in

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the boiler after the manner of the Babcock & Wilcox boiler. On the other hand, they permit the replacement of a defective tube and of the cleaning of a tube much more readily than the tubes which are bent. Likewise it is only necessary to carry one size of spare tubes, while the best tube boilers require several sizes and shapes.

As far as safety against explosion is concerned, there can be no doubt that there is less danger of an actual disaster affecting the whole ship, although the worst accident which we ever had with a boiler in my naval experience was in connection with a water tube boiler on a torpedo boat where all the crew of a fire room were scalded to death. Nevertheless, the boiler itself did not explode and was quite easily repaired. On the other hand, a few years before this a locomotive boiler on a torpedo boat in Germany exploded through the collapse of a crown sheet due to low water, and not only killed all the people in the fire room, but tore up the decks and utterly ruined the boiler itself. In this connection it is a cause of sincere congratulation that since the explosion of the Thunderer's boilers in the English navy many years ago there is, I believe, no record of an explosion of large, well-built, marine boilers. For naval purposes, where weight is such a great consideration, the water tube boiler commended itself at once, and it has now become the established practice in all navies to use only water tube boilers in new ships. Our English friends had some trouble with the Belleville boiler, but this seems to have been due to some extent to lack of familiarity with it, and other legitimate reasons. In the merchant service where weight is not so precious, the water tube boiler has not thus far so thoroughly commended itself to designers; and, as remarked earlier, all of the latest large vessels are still using cylindrical boilers. Some of the reasons for the hesitation to adopt water tube boilers are that of necessity an installation of large power means a very large number of boilers, because the water tube boiler does not admit of single units of great power comparable with the large double-ended cylindrical boilers. This means an immensely greater complication in the way of piping, valves, fittings, feed pumps, etc. Moreover, owing to the small amount of contained water, which is very desirable in so far as weight is concerned, the water tube boiler is very sensitive as regards steam pressure and water level, requiring very much more care and attention than the cylindrical with its immense amount of contained water. It seems to me not impracticable that the able men who are engaged in the study of this question will finally succeed in developing a type of water tube boiler which will commend itself for use in the merchant service as well as in the navy. Some of the boilers fitted in the United States naval ships had but six minutes of water endurance after the pumps stopped working, while one of those, the Babcock & Wilcox, adapted to our naval use, has as much as twenty-five minutes' endurance, which is a close approximation to the Scotch boiler.

AUXILIARIES.

In the early steamers, almost the only independent steam auxiliary was a single pump which could be used for feeding the boilers while under banked fires or with the engine stopped, and for pumping the bilge. The other pumps were attached to the main engine. Such things as steam capstans and winches, steam steering gear, distilling apparatus, evaporators, forced draft blowers and electric light engines, were not dreamed of. As time went on and the size of vessels increased, steam capstans and winches and steam steering engines came in. Then it began to be found desirable, particularly for naval engines, to remove all the pumps from the main engine, leaving it nothing to do but turn the propeller, and this brought about independent air and circulating pumps and feed pumps. Further progress introduced the distiller and evaporator, the forced draft blowers and the electric light engine.

Most of these auxiliaries, from the nature of the case, are driven by simple engines, the pumps usually being for very slow piston speed and without expansion. The result is that the economy of these auxiliaries is naturally very low, and for some years past it has been the aim of designers to do something to either make the auxiliaries themselves more economical, or at least utilize the heat in the exhaust steam. In some cases it has been arranged to have the auxiliaries in the engine room take their steam from the first at receiver and exhaust into the second, thus in effect making all their cylinders part of the intermediate cylinder, as far as the steam cycle is concerned with its attendant economy. I remember one of my former associates telling of how he had actually tried this on his ship with a saving of some six tons of coal a day, for machinery which was then working at about 3,000 H. P. In the case of the feed pumps, arrangements have been made to turn the exhaust steam into the suction pipe, thereby having this heat carried back into the boiler, but this has not been done to any great extent. Another plan has been to turn the exhaust from all the auxiliaries into a feed water heater through which the main feed to the boilers would go, and this has been attended by very good results.

The question has been raised repeatedly by electrical engineers that it would be a good plan to drive the auxiliaries by electric motors, on account of their very high efficiency even at fractional loads. For the engine room auxiliaries and the boiler feed pumps it seems to me that this is unreasonable, for it means increased complication and certainly an increase in weight; and it has never been shown to my satisfaction that there would be any material increase in economy, owing to the fact that the dynamos as usually supplied on board ship are not large enough to have very economical engines, and from the fact that there are so many machines each with an efficiency less than unity in the circuit between the boiler and the final pump.

There are some auxiliaries on board ship, however, where it would seem motors could be used to advantage, notably for driving the forced draft blowers. From the necessities of the case they are usually stowed in hot and rather inaccessible places and it is difficult to keep the engines in good adjustment. It hardly seems to me, however, that direct current motors are well adapted to this service, as they would have to be of the enclosed or dust proof type, which reduces their heat carrying capacity, and as they have to go in places where the heat is already very great. If alternating current machinery were installed, it seems to me that the induction motor with its extreme simplicity and ability to withstand very hard usage would be especially adapted to this work.

It is doubtless known to all of you that in the modern ships the turret turning is done by electric motors. While this is an engineering matter, on board ship it comes within the perview of the ordnance officer, and therefore I have not dwelt upon it. The anchor capstan and steering engine should be electrically driven, but because of peculiar conditions existing in the navy this has not been done.

THE STEAM TURBINE.

The latest note of progress in marine engineering seems to be the advent of the steam turbine, which for some purposes has passed the experimental stage, and has given great satisfaction. As already mentioned, a number of small vessels of the torpedo boat class have been built with steam turbines, and this has been followed up by their use in a number of excursion steamers and cross channel steamers between England and France and England and Ireland. The Allan Line of steamers have also decided to equip a large new steamer with turbines, and as all know from the technical press, the Cunard company have had a very able committee considering the question of their adoption for the two

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new flyers which that company is to build—as a result of which they have decided to use turbines in them.

The turbine has had an extended use in the last four or five years on shore for driving electric generators, and this has been so satisfactory that the pioneer work of the Westinghouse company in this country has been followed by the General Electric Co., the Allis-Chalmers Co. and a number of other engine builders, who seem to have reached the conclusion that for large powers at least the turbine is quite sure to supersede the reciprocating engine.

For constant speed at its rated load the turbine is very economical, comparing in this respect with the most economical reciprocating engines, and its economy does not fall off so rapidly with decrease of load at constant speed as is the case with the reciprocating engine.

For marine purposes two questions have bothered those who were seeking information, one the question of reversal and the other that of economy where not only the power but the speed is reduced, as is, of course, necessary in the propulsion of vessels. With respect to the former, different methods have been suggested and tried in different cases. In some instances Mr. Parsons has used separate reciprocating engines which are normally idle. In others, and this appears to be in his latest practice, there are reversing turbines inside the exhaust passage of the ahead turbines, so that while the ship is going ahead these turbines revolve idly, after the manner of a fly wheel, in an excellent vacuum. When the ship is to be reversed, steam is admitted direct to these turbines and secures the reversal.

With respect to economy, there is, of course, a marked falling off from that at full power, but not more so than in the case of reciprocating engines. It seems hopeless to expect that any machine will work with the same economy at one-tenth power that it does at full power, and it would be unreasonable to expect the turbine to do this when the reciprocating engine does not.

The advantages of the turbine are, the entire absence of reciprocating parts, of bearings to be adjusted and the extreme simplicity of operation, together with the great reduction in weight due to the very high speed. Added to this is the entire freedom from danger due to priming of the boilers, the only result being a slowing down of the turbine and reduction of economy. There is also freedom from lubricating oil getting into the boilers.

Propeller design with the turbine is more difficult than with the reciprocating engine, because the conditions are entirely different from those which have hitherto obtained, and there is so little experience with propellers running at speeds of over 1,000 revolutions a minute in the case of small ships, or at 500 to 750 in the case of large ones. The Cunarders' propellers, it is understood, are to be limited to 150 revolutions per minute. For it must be remarked that in spite of the fact that we now have very clear and logical rules for the design of propellers under existing circumstances logically worked out, nevertheless these rules and formulae came after the experience rather than before. This matter, however, can undoubtedly be cared for, and when more experience has been gained the design of propellers will be as easy for existing conditions.

For naval vessels from a military standpoint the turbine has a great deal to commend it, inasmuch as the machinery will stow very well in the ship and be out of harm's way, the propellers are so small and so well immersed that there is no chance for racing even in the heaviest seas, and all questions of vibration are eliminated. As already mentioned, the saving in weight is also a matter of decided value, if it can be done.

CONCLUSION.

We have now considered very hastily the important epochs in the history of marine engineering, and it will be seen that they indicate steady progress along certain lines. There has been a steady increase of steam pressure, increase of rotational speed and diminution of weight, accompanied by increased economy in the making and using of steam. If time had permitted it would have been very interesting to compare such a vessel as the Great Eastern which for so long a time was the criterion of immense size, with the Celtic and Cedric, which are even larger than she was. The Great Eastern was simply about thirty years ahead of her time. She was a remarkable production and a great credit to her designers in every way, but she was a commercial failure because marine engine manufacture had not yet reached the point where such a huge vessel could be operated profitably. She carried more than twice as much coal as one of these present-day vessels, which easily makes the same speed with machinery weighing probably not more than one-third of what her's did.

The economy of the marine engine, or of the turbine if it displaces the engine, has reached a point which does not leave much room for improvement in materials and workmanship. Yet it will be unreasonable to believe that we have reached finality, for it is likely that there have been numerous periods in the past when the designers of those days could not see what the next step in advance would be, and so far as their knowledge went their design was nearly perfect. Of course, there was certainly plenty of margin for increased economy with them from which we are barred, but I have no doubt that if I could live to be as old as Hr. Haswell I should see some decided improvements in the course of the next thirty years.

INSPECTING OAKLAND HARBOR

On Feb. 14 United States Senator-elect Frank P. Flint of California, U. S. Senator-elect George S. Nixon of Nevada and Congressman-elect Duncan McKinlay of the second district of California made a tour of inspection of the harbor of Oakland, Cal. The cutter Golden Gate, commanded by Capt. J. C. Cantwell, conveyed the party, which included John Mitchell, chairman of the supervisors of Alameda county; the president and secretary of the Merchants' Exchange of Oakland; the editor of the Oakland Enquirer; the secretary and several members of the Oakland board of trade. Senator Flint was supplied with maps, photographs and data about the development of Oakland harbor, which is now receiving the overflow from the congested water front of San Francisco.

Senator Flint stated that the great competitor of San Francisco harbor for the trade of the Pacific ocean is Seattle, which is fighting for the business of the orient. In order to make San Francisco the distributing point for the Pacific coast it is necessary to improve Oakland harbor so as to provide greater dockage room for the commerce of San Francisco bay.

The party was entertained at luncheon at the Claremont Country club, Warren Olney, the mayor of Oakland, making the speech of welcome.

The delicate job of pulling the barge Constitution apart 72 ft. and making ready for rebuilding her took place at the Superior Ship Building Co.'s yard last Saturday morning. It took just 17 minutes to complete the work, which is record time; the nearest approach to it was 22 minutes at the Chicago Ship Building Co.'s yard. The Constitution occupies one dry dock and the steamer Victory the other, both pulled apart for a 72-ft. addition. There are about 350 men in the yard now, and the great ship for the Pittsburg Steamship Co., 569 ft. over all, is well in frame. Mr. Robert Logan, general manager of the American Ship Building Co., was at Superior Saturday, to inspect the progress of work.

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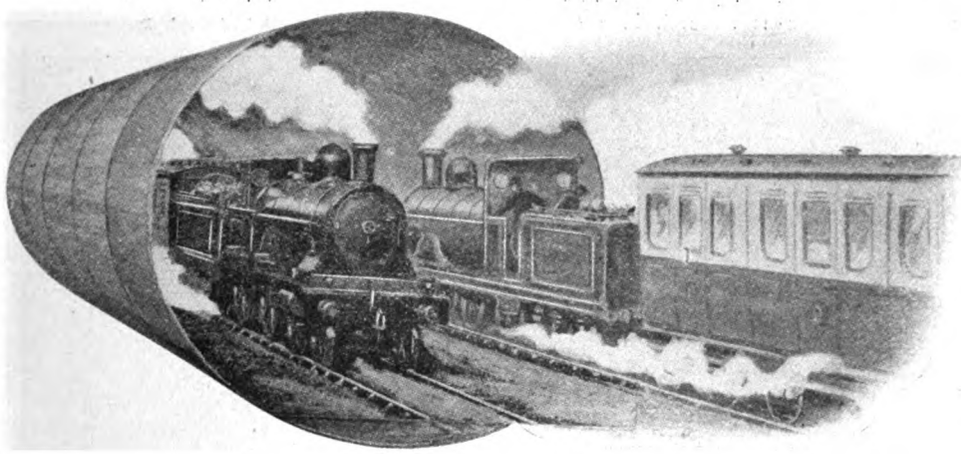
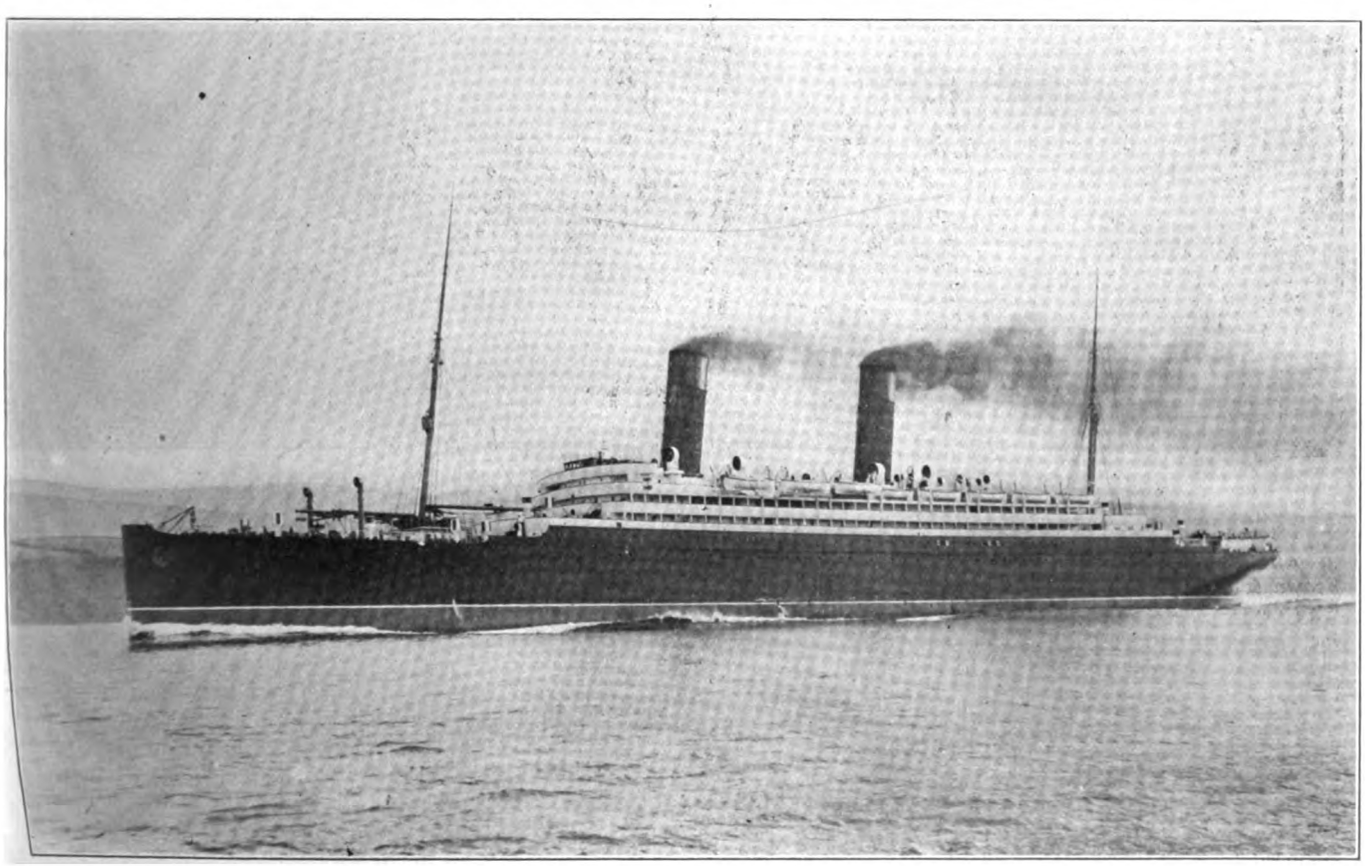
CUNARD LINER CARONIA

Especially interesting at this time is a description of the Cunard liner Caronia, her engines and her speed trials. As known, the Caronia is fitted with reciprocating engines while the Carmania, her sister, is to be fitted with turbines of the Parsons make. There are only three or four vessels of greater tonnage than the Caronia and Carmania, and the difference is due to the aim to carry more cargo in the larger vessels. The Baltic, which is the biggest ship afloat, is 48 ft. longer, and has a gross tonnage about 2,800 tons greater, while in view of her fuller lines and greater cargo, she will in service have a displacement considerably higher, but her speed on the Atlantic is 17 knots. The over-all length of the Caronia and Carmania is 678 ft., and the molded breadth 72 ft., making the displacement 29,800 tons when the vessel is fully loaded to a draught of 32 ft. In order to attain a speed of 19 knots under economical conditions, a smaller coefficient of fineness was decided upon than has been adopted in previous so-called intermediate steamers, it being under 0.7, which compares with about 0.55 for some cruisers; but with the great length possible in ships for merchant service, the naval architect does not require to fine the ends of his ships to the same extent as in the short beamy armored vessel. Thus it may be assumed that even in the 25-knot ship, the coefficient will be somewhere about 0.6. But, to return to the question of size, the molded depth of the Caronia is 52 ft., the height from keel to navigating bridge is 90 ft. and to the top of the funnels 144 ft. In her construction 12,000 tons of steel were required, with 1,800,000 rivets. Many of the plates were 1⅛ in. thick, 32 ft. long and 5½ ft. in width, quadruple riveted with 1⅛-in. rivets by hydraulic pressure. She may carry 3,450 tons of water ballast, 12,000 tons of cargo, and 300 first, 350 second, 1,000 third, and 1,000 steerage passengers. These, with the crew of 450 officers and men, make an aggregate of 3,100.



TWO RAILWAY TRAINS CAN PASS ABREAST THROUGH THE CARONIA'S GIANT FUNNEL.

Chief interest, however, in connection with the Caronia and Carmania centers in the propelling machinery. The former is fitted with quadruple-expansion engines, driving twin-screws; for the latter, launched on Feb. 21, there is now being constructed at Clydebank, an installation of Parsons' steam-turbines to drive three screws. Opportunity will thus be



THE CUNARD LINER CARONIA WHICH IS JUST NOW MAKING HER MAIDEN TRIP TO THIS COUNTRY.

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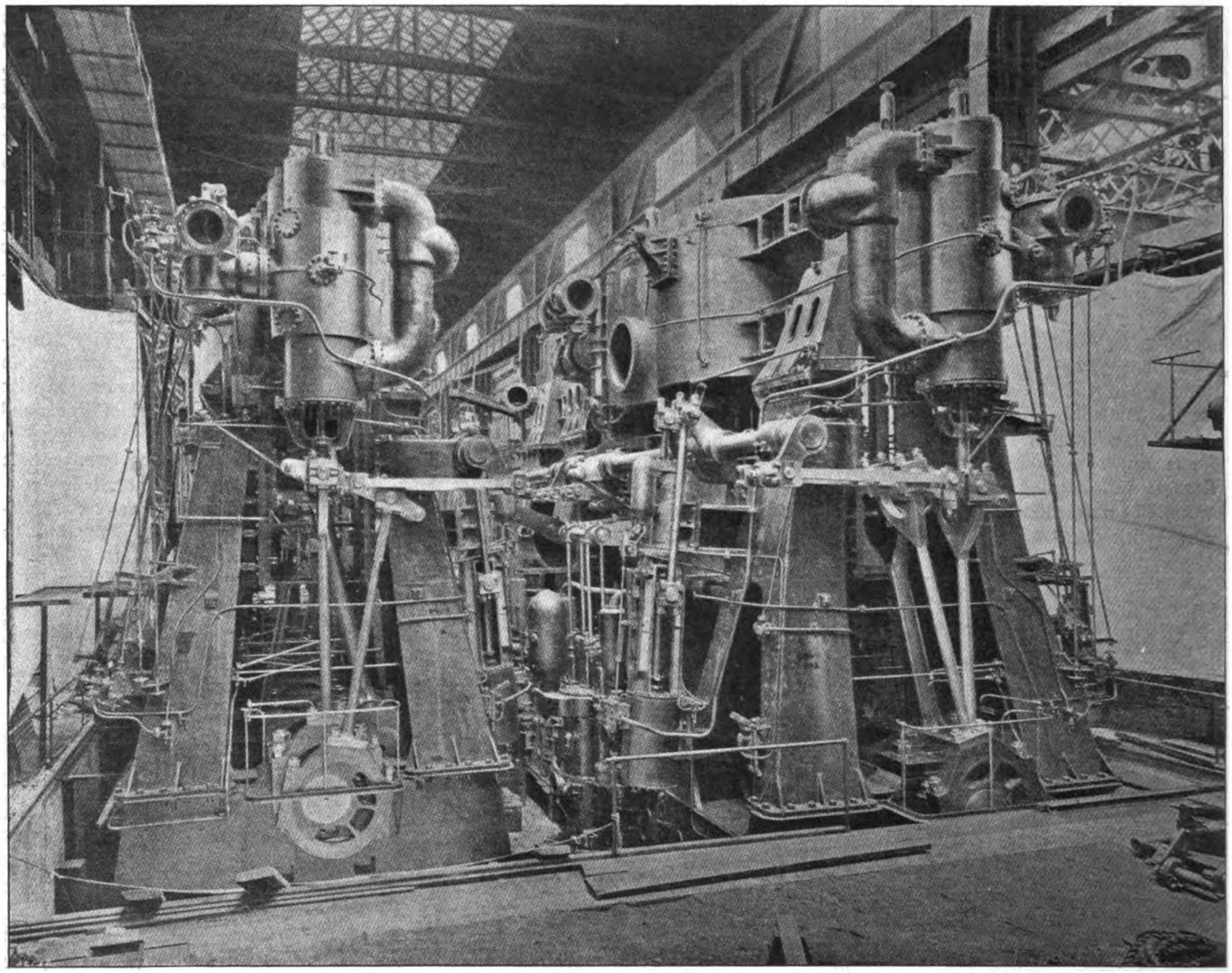
given of testing the comparative economy of the systems in the Atlantic service; and, while doubt as to the potentialities of the newer prime mover have almost disappeared, except in the minds of most conservative engineers, the results will always be valuable, so that Lord Inverclyde and his company are to be felicitated not only on the bold step of adopting the system for the 25-knot ships, but particularly for affording means of a thoroughly reliable test in the most severe of steamship services. It may be claimed that, so far as the reciprocating machinery is concerned, full justice will be done as an outcome of the experience of the Clydebank staff, while at the same time a year's continuous research in a special



THE GREAT ENGINES OF THE CUNARD LINER CARONIA.

turbine experimental department, and in the ship model and propeller testing tank at Clydebank, has enabled Messrs. J. Brown & Co. to determine many uncertainties in connection with details as to the design, and especially as to the manufacture, of the turbines. The time has barely come for reviewing this experimental work, but one or two points may be dealt with.

In the first place, however, reference must be made to the reciprocating engines. Standing in the engine-room one could not help being impressed not only with the great size and suggestion of strength, but also with the easy motion of these engines. There is no longitudinal bulkhead between the two engines, and their appearance when running at 90 revolutions was therefore the more impressive. The total height from the center of the shafts is 30 ft., and from the base of the bed-plate 36 ft. The diameters of the respective cylinders are 39 in., 54½ in., 77 in. and 110 in. The latter, with one exception, is the largest cylinder yet adopted for vertical engines. The stroke is 5 ft. 6 in., and the length of the connecting-rods 12 ft. between centers. This length is conducive to efficient working, and in this respect the merchant ship has a great advantage over the warship. In the latter, with engines of corresponding power, the stroke would be only 4 ft. 3 in., with a connecting-rod 8 ft. 6 in. between centers. Again, the weight allowed for machinery is probably double that placed at the disposal of the warship-builder; naval machinery requires to make 40 per cent more revolutions for full power. While the naval engine is only expected to run at full speed in cases of emergency, and even then only for short periods, the Caronia's machinery has been built to run year in and year out at full speed, irrespective of weather, and consequently many conditions had to be taken into account in the proportioning of parts which do not apply in the case of naval machinery. Merchant-ship boilers are thus made of sufficient capacity to maintain the full power continuously, even when a certain number are shut down for cleaning fires; in the naval service the boilers are usually proportioned to maintain continuously four-fifths of the power, the remainder required for full speed being got under pressure. The Caronia boilers, have thus 2.35 sq. ft. of heating surface per unit of power, Howden's system of forced draft being used, as against 2.7 sq. ft. for natural draft in cruisers; the power per unit of grate

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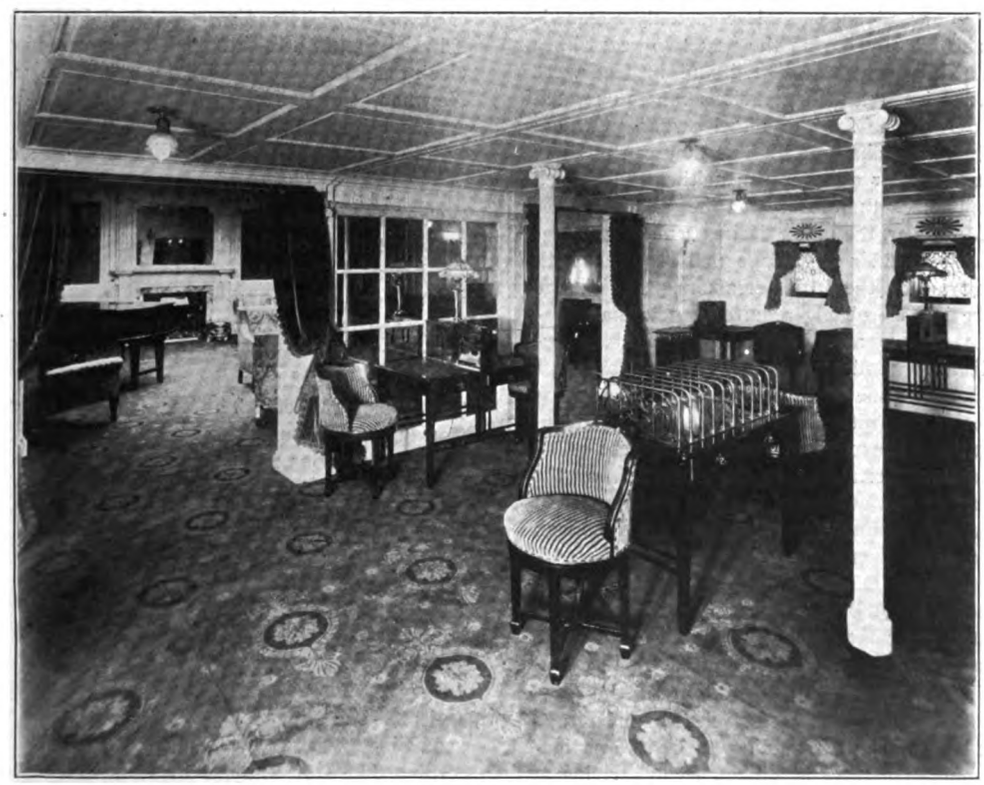
area is 17.3 I. H. P. and 13 I. H. P. respectively. The Caronia's machinery has been evolved from that of the Saxonia, which was tested by the naval boiler committee, and required only 13.4 lb. of steam per horse power per hour, against 16 lb. in the naval ships tested; while the boilers, with Howden's system of forced draft generated 12.33 lb. of steam per pound of coal, as compared to 9½ lb. to 11 lb. in the naval ship. The coal consumption per unit of power was 1.29 lb. There is every promise that in the Caronia the results will be at least as good, so that the standard set for comparison with the turbine installation in the Carmania will do full justice to the reciprocating type of machinery.

FIRST CLASS DINING SALOON OF THE CARONIA.

As regards the Carmania, the only difference will be in the propelling machinery. The form of hull, except so far as modified for the propellers, and the boiler installation, will be exactly the same. There will be, as in all recent installations, three shafts, the center shaft being driven by the high-pressure turbine, while the side shafts will be worked by the low-pressure system, with the go-astern turbine at the after end fitted inside the low-pressure casing. The space occupied, so far as area is concerned, will be the same as in the Caronia; there will be a saving in weight by the adoption of the turbine system of about 5 per cent. The boiler pressure will be reduced from 210 lb., as in the Caronia to 195 lb. in the Carmania. The turbines will take steam at an initial pressure of 165 lbs., as against the 200 lbs. in the quadruple-expansion engines. Owing to the high vacuum desirable in the turbine system to ensure the fullest economy, the condensing surface, which in the Coronia is 27,030 sq. ft., will be increased in the Carmania by 20 per cent, while the capacity of the centrifugal pumps will be increased by about 50 per cent., so that the amount of circulating water that they will be capable of discharging will be from fifty to sixty times the weight of feed water, as compared with a ratio of from twenty-five to thirty times in the Caronia installation.



WRITING ROOM OF THE CARONIA WITH DRAWING ROOM IN BACKGROUND.

The trials of the Caronia resulted very satisfactorily. In the first place a series of progressive speed runs was made over the measured mile at Skelmorlie on the Clyde, with the fol-

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lowing result :

Revolutions.	I. H P	Speed, knots.
69.6	10,400	15.72
74.5	12,350	16.61
80.9	15,500	17.76
85.2	18,900	18.80
89	21,600	19.51

After these progressive runs the ship continued at full power for some time, and the results, so far as engines were concerned, were as follows:—Revolutions of port engine, 90.9; power, 11,550 I. H. P.; revolutions of starboard engine, 91.2; power, 11,527 I. H. P. The collective power was thus 23,077 I. H. P. The official full-power trials commenced at noon on Monday. The mean result of four runs on the measured mile was as follows:—89.2 revolutions; 21,870 I. H. P.; 19.62 knots; and this speed and revolutions were maintained for a total continuous period of 13½ hours. Indicator cards were taken at regular intervals during the trial, and the highest power recorded was about 23,500, the results of the previous trial on the 4th inst. being thus verified in all essential details.

There was on board a new instrument which accurately records the horizontal as well as vertical vibration of the ship, and the results prove that this has been reduced to a minimum by the perfect balancing of the engines. The records of the vibrations will be most instructive when compared with similar diagrams to be obtained from the turbine-driven ship Carmania.

CONFERENCE WITH SEAMEN'S UNION

The executive committee of the Lake Carriers' association are now engaged in putting in a week of serious work with the representatives of the Seamen's union. During the past two or three years the wage scale on the great lakes has been an ascending one and the seamen have not failed this year to ask for the customary advance. It is commonly acknowledged that wages aboard ship during the past two years have been more than earnings have warranted and in fact were something of a burden last year when various causes operated to make the year a lean one for the vessel owner. Owners feel that the scale has gone about as high as they can possibly stand and feel that a further advance can neither be justified nor borne. No advance, therefore, will be allowed over last sason's scale. Moreover, the union desires a new classification which works out to their advantage and requires additional men to be carried on the larger steamers. The change in conditions on the lakes probably requires a new classification but, of course, this is a subject which should be approached with deliberation and owners feel that it should not be projected at fitting-out time when everyone is more or less rushed. The executive committee was assisted in their deliberations by a delegation of masters of vessels who were called in to pass upon matters pertaining to the operation of the vessels. This is further recognition of the fact on the part of the owner that owners' and masters' interests are identical. The masters present were Capts. G. B. Mallory, James Morgan, S. C. Allen, William D. Haynes, John Dorrity, C. M. Ennes, H. H. Parsons, J. W. Bryan, Robert Murray and Fred Bailey. A committee was appointed from among the masters to consider certain of the conditions submitted by the Seamen's union which pertained to the operation of the ship. The purpose of this was to have matters clearly understood so that there might be no misunderstanding during the navigation season. No trouble whatever is anticipated in arriving at a satisfactory settlement before the week is out, but it is predicted that it will be precisely upon the same conditions and scale that obtained last year. As soon as the wheelsmen, watchmen and lookouts have been disposed of the case of the cooks will be taken up. The Lake Carriers' association is represented by President Livingstone, Harry Coulby, Edward Smith, J. C. Evans, William Hawgood, Joseph Gilchrist and Capt. Dennis Sullivan.

FREIGHT SITUATION

Representatives of vessel interests are at present entirely concerned with the labor problem and there is virtually no discussion whatever upon freight rates at present. It has not been broached by the shippers, neither has it been urged by the vessel owners. It is appreciated, of course, that the coming season will be a very busy one and undoubtedly as soon as the labor question is out of the way season chartering will speedily be entered into. The lake trade is undergoing constant refinement and there is a better understanding between shippers and vessel owners. The rate no longer fluctuates widely but has relation to the actual investment and risk involved. Shippers are willing to pay a reasonable rate and the vessel interests are content to accept such. There has therefore been no serious discussion of rates so far, but as soon as the labor question is out of the way it will be but a very few days before the chartering of tonnage aggregating millions will be entered into. As to the movement of ore, it is a foregone conclusion that it will be heavy, probably reaching or exceeding 30,000,000 tons.

GREAT LAKES TOWING DIVIDEND DECLARED

The directors of the Great Lakes Towing Co. at a meeting held in their offices in Cleveland on Wednesday declared a quarterly dividend of 1¾ per cent payable on April 1 to stockholders of record March 15. This is the second dividend, the first having been declared in January, and shows the wisdom of the policy which had previously been pursued by Mr. Harry Coulby and Mr. Ed. Smith in building up the physical property of the company. It is now in excellent condition to earn money. The directors elected the following officers: Edward Smith, president and treasurer; James Davidson, first vice-president; A. B. Wolvin, second vice-president; T. F. Newman, third vice-president; M. H. Wardwell, secretary. A general manager has not yet been selected by President Smith to succeed Cyrus H. Sinclair, resigned.

Conference was held in Cleveland this week between the representatives of the fish companies at Lake Erie ports and the Licensed Tugmen's Protective association. The tugmen's association was represented by President D. J. Keefe and various delegates from the tugmen's association. A wage scale for the season was entered into which was satisfactory to both sides. Later the wage scale for fishermen aboard tugs was arranged. The scale is the same as last year but working conditions are somewhat improved, though the demand of captains and engineers for a season of eight months was not allowed. A uniform scale at all Lake Erie ports was then adopted for fishermen, being the same as last year, $15 for a week of six days and 35 cents an hour for overtime.

It is likely that the fleet of the Toyo Kisen Kaisha will soon be running as usual between San Francisco, Honolulu and the orient. The steamer America Maru is at the Sasebo navy yard but no work has been done in equipping her as a cruiser. The Nippon Maru and Hongkong Maru are scouting near Singapore for the Russian Baltic fleet. As soon as it is certain that the Russian fleet has returned to Europe the Japanese government will give back the merchant ships to their owners. It is probable that the Japanese liners will resume their regular runs in the spring.

An order for the construction of three 12,000-ton vessels has been placed at the Nagasaki ship building yards, the Japanese government having offered a liberal subsidy.

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DEVOTED TO EVERYTHING AND EVERY INTEREST CONNECTED OR ASSOCIATED WITH MARINE MATTERS ON THE FACE OF THE EARTH.

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MARCH 2, 1905.

Hon. T. E. Burton, chairman of the committee on rivers and harbors, achieved a signal triumph in the house of representatives last week by passing the rivers and harbors bill without a dollar being added to it or subtracted from it after it left the committee's hands. This is an exhibition of extraordinary ability, particularly when it is known that powerful interests had combined to defeat the passage of any bill whatever.

The Board of Supervising Inspectors of Steam Vessels have concluded their work in revising the steamboat rules and in general have listened to the advice of the leading representatives of shipping interests who have appeared before them. Nearly all of the objectionable provisions, which were inserted in the regulations, have been modified in accordance with the counsel of the steamship lines and some of them have been withdrawn altogether. In fact a number of the provisions, had they been incorporated in the rules, would have done more harm than good. In this connection Mr. Harvey D. Goulder, counsel for the Lake Carriers' association, who has spent the past month in Washington, has done great service. The steamship owners of the country are naturally more desirous than anyone else can possibly be to make their vessels perfectly safe and to observe any rules that will tend to insure their safety. They have been willing to do all that is necessary and have merely asked that unnecessary regulations should not be imposed upon them. The crew complement was left to be determined by the local inspectors as it should be and it is hoped that the senate will have the good sense to leave it so.

The present congress is upon the heels of its existence and nothing has been done in a practical way for the promotion of American shipping in the foreign trade. To be frank, however, this is no more than was expected at the beginning. In the first place the session was a short one and the amount of business to be accomplished in it necessarily very great. There are certain legislative enactments which cannot be postponed, notably the appropriation bills for the maintenance of the various departments of government and other measures which call for much time in their consideration. Moreover, the report made by the Merchant Marine Commission upon the shipping question was exhaustive and thorough and could not be hastily digested. The real gain has been in the projection of the shipping question before the people. Probably during the past year more people have studied this subject than at any other time in the history of the country. The tour of the Merchant Marine Commission was productive of great good in this regard. It caused people to think and the information submitted to the commission was widely disseminated throughout the length and breadth of the land. It is certain that its character has convinced many senators and representatives of the urgent need of governmental aid to shipping if the American flag is not to disappear altogether from the high seas. This great educational work will continue and in all likelihood the shipping bill presented to congress by the Merchant Marine Commission will be enacted into law at the next congress. It certainly will be if the administration gives to it the support which it has promised.

It is needless to expect that any rehabiliment can take place in the shipping of our foreign trade without government assistance. Every other nation either directly or indirectly aids its shipping. It is a favorite claim of the Germans to say that they do not aid shipping but they allow differential railway rates on goods intended for export in German ships. What is that but aid to shipping? Britain stoutly maintains that it does not aid its great fleet of tramp steamers, but it conveniently forgets that this great fleet came into existence through subsidies steadily and continuously given to project mail carrying steamers upon ocean routes leading to all ports of the world. Trade once being established to these ports naturally other steamers followed. The innumerable trading steamers flying the British flag are the direct result of wise and intelligent aid given to the mail steamships of Great Britain in the early days of steam navigation.

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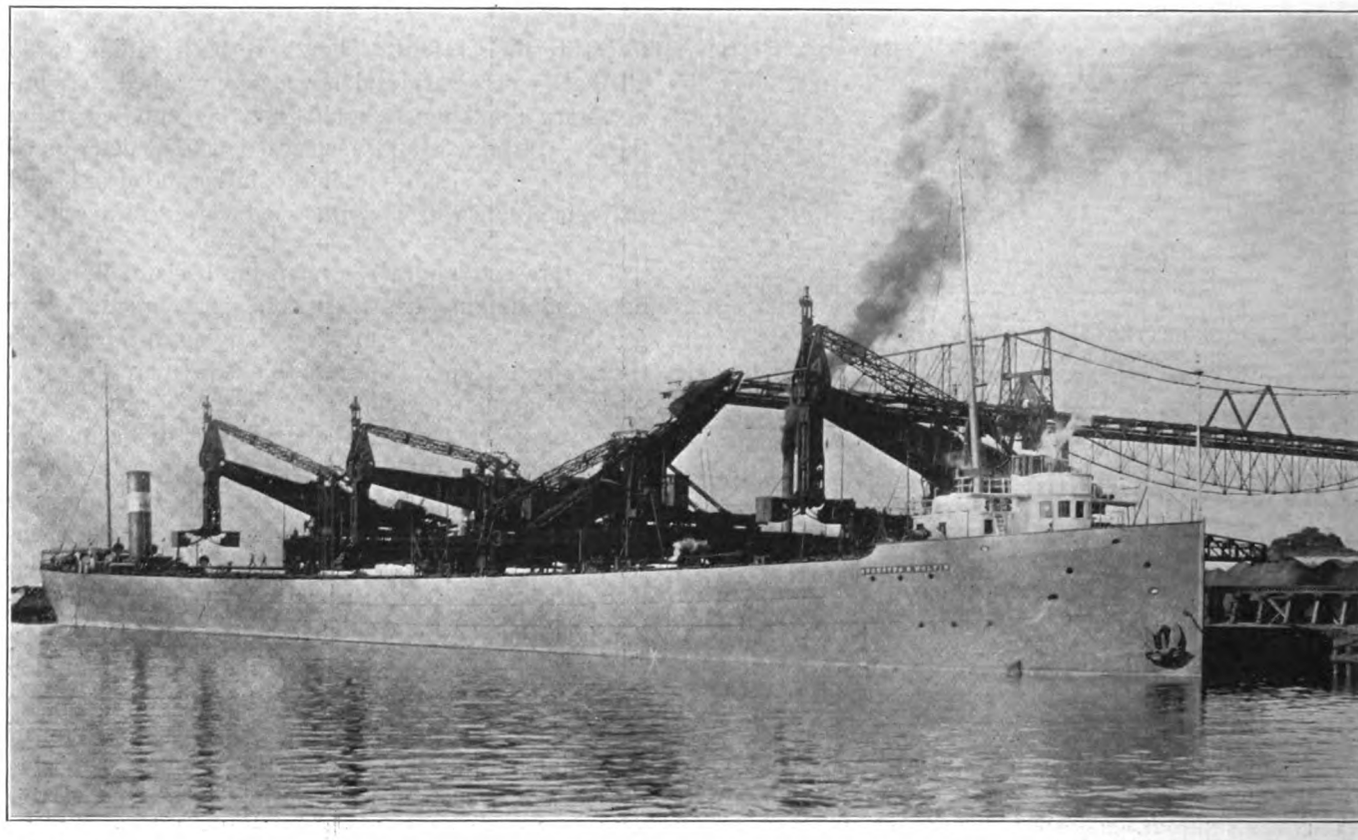

PHOTO NO. 1 SHOWS FOUR HULETT AUTOMATIC ORE UNLOADERS AT THE STEEL CORPORATION'S DOCKS, CONNEAUT. THESE MACHINES HOLD THE WORLD'S RECORD FOR UNLOADING 7,257 GROSS TONS OF IRON ORE IN 4 HOURS 30 MINUTES—OVER 400 TONS PER MACHINE PER HOUR.

Hulett Clam Shell Unloading Machines

Numerous inquiries have been received by the Marine Review for information concerning the unloading record established by the four Hulett clam shell machines in discharging the cargo of the steamer Augustus B. Wolvin at the Pittsburg & Conneaut Dock Co.'s dock, Conneaut, on July 25 last. These inquiries have been coupled with requests for descriptive data of the machines themselves, and the purpose of this article is, therefore, to supply both. It will be understood that the latter-day type of ore carriers, of which the Wolvin is a fine example, lends itself especially to quick discharge in unloading since its hold is practically unobstructed by stringers, stanchions or any obstruction to the free play of the unloading machines, rigidity being secured by enormous arch girders directly under the deck.

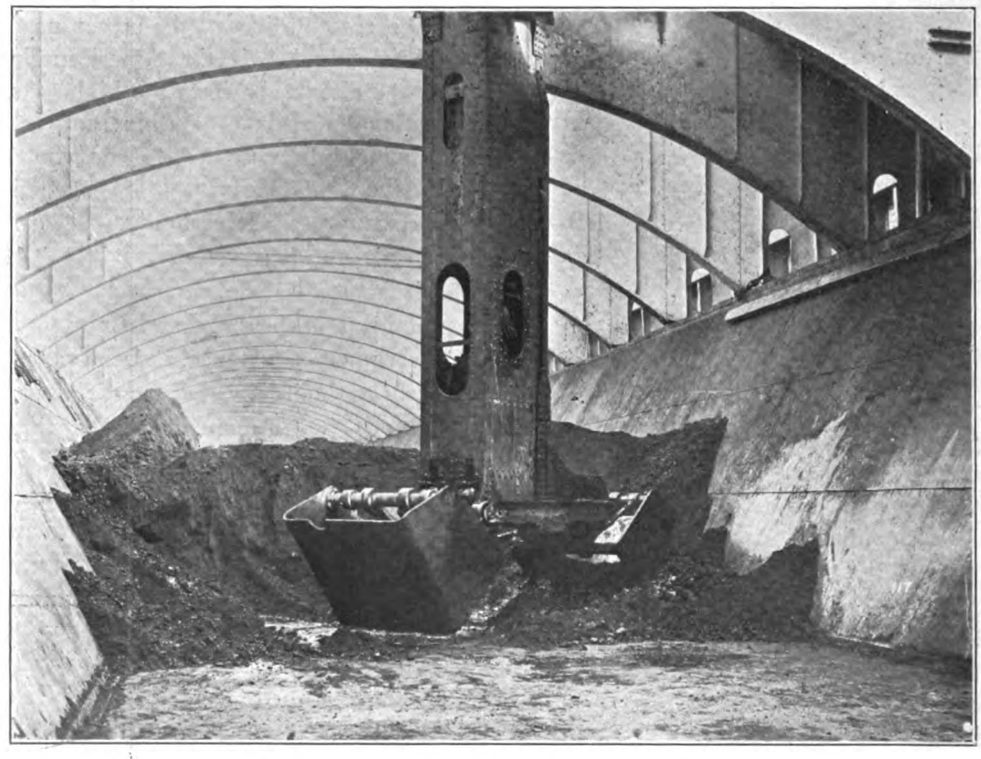

PHOTO NO. 2 SHOWING LEG AND BUCKET OF HULETT UNLOADER AT WORK IN THE HOLD OF THE STEAMER AUGUSTUS B. WOLVIN.

The actual time the Wolvin was under the unloading machines was 4 hours and 30 minutes, or from 7:22 a. m. to

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11:52 a. m. The average time that the four Hulett clam shells were working upon her was 4 hours, 6 minutes, during which time they took out 7,257 gross tons of ore, an average of over 403 tons per hour per machine. The maximum amount taken out in any one hour was 681 tons by the No. 3 Hulett machine. The total cargo of the Wolvin upon this occasion was 9,945 gross tons, the balance, 2,688 tons, being discharged in 3 hours,

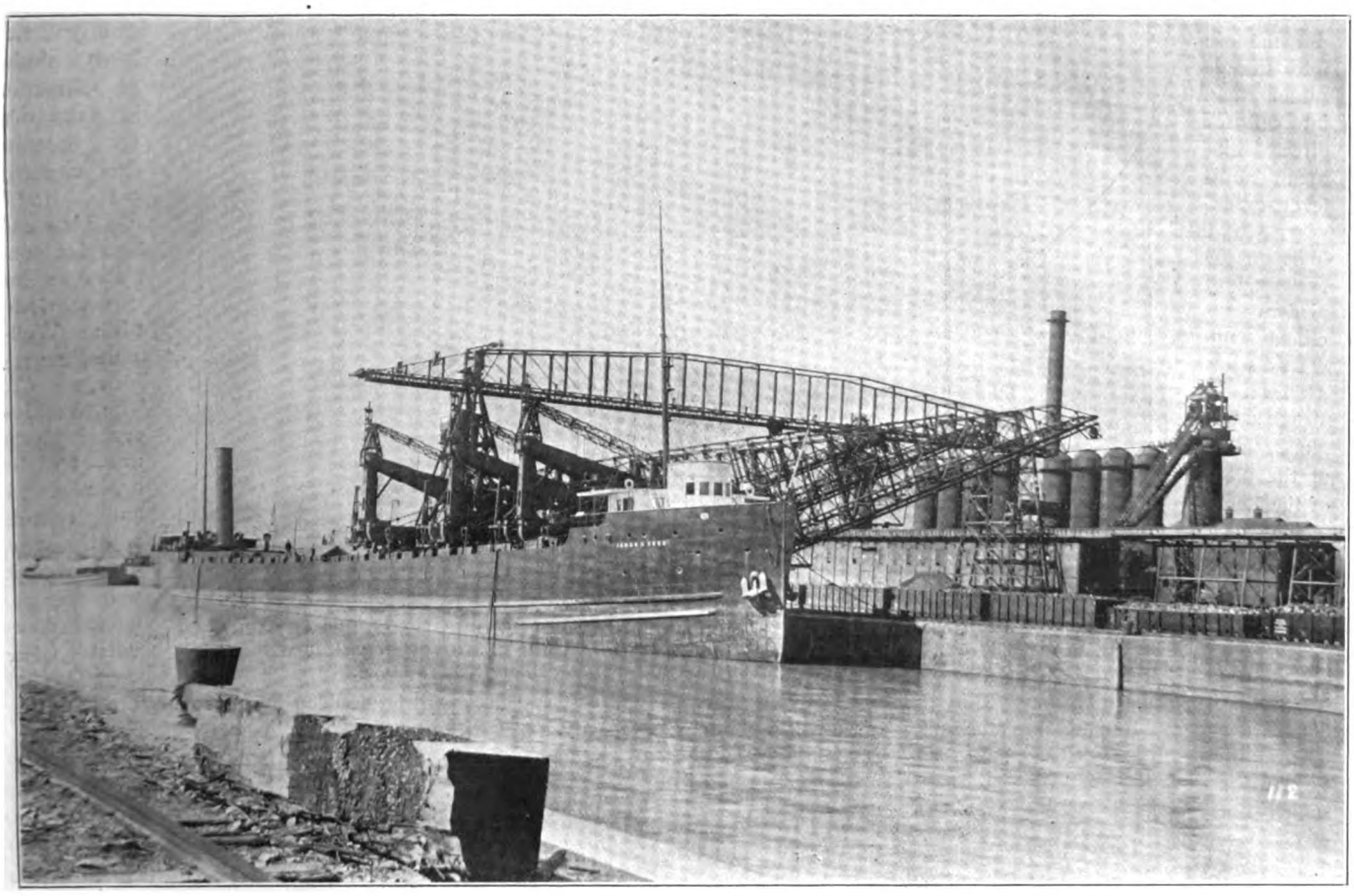

PHOTO NO. 3 SHOWS THREE OF FIVE HULETT AUTOMATIC ORE UNLOADERS AT LACKAWANNA STEEL CO.'S PLANT, BUFFALO.

41 minutes, by four Brown electrical machines. The following table shows precisely what each machine accomplished in this remarkable unloading record:

HULETT CLAM SHELL MACHINES.

Machine No. 1, 1,654 tons; 4 hours, 17 minutes.
Machine No. 2, 1,636 tons; 3 hours, 55 minutes.
Machine No. 3, 2,089 tons; 4 hours, 03 minutes.
Machine No. 4, 1,878 tons; 4 hours, 08 minutes.
Total tons 7,257; average time 4 hours, 6 minutes.

BROWN ELECTRICAL MACHINES.

Machine No. 1, 625 tons; 3 hours, 30 minutes.
Machine No. 2, 717 tons; 3 hours, 50 minutes.
Machine No. 3, 769 tons; 4 hours, 04 minutes.
Machine No. 4, 577 tons; 3 hours, 19 minutes.
Total tons 2,688; average time 3 hours, 41 minutes.

The Hulett automatic ore unloaders are designed for automatically unloading iron ore from vessels. They are built for steam or electric operation as desired. Each machine has two parallel girders at right angles to face of dock, and mounted on moving trucks. On these girders the trolley or carriage carrying a walking beam travels back and forth over the hatch of the vessel and back again. This walking beam has, at the front of the vessel end, a vertical leg provided at the lower end with an automatic bucket. The operator rides on the leg directly above the bucket. By means of hoisting mechanism the walking beam oscillates up and down, carrying the bucket down into the hold of the boat, and up back on the dock. When the bucket reaches the pile of ore in the hold, it is closed, filling itself with ore. The leg is then raised up and out of the hold, carried back over the dock and the bucket opened, dumping the ore either into bins, discharging into railroad cars underneath, or into an auxiliary "bucket car," in case the ore is to be carried back to tracks beyond or to stock pile. The leg of the unloader is mounted on rotating trunnions in the walking beam so that it can turn around in a circle when operating in the hold of the vessel, thus allowing the bucket to reach out in all directions beneath the hatch. The bucket is opened and closed by hydraulic power when steam is used, or by specially designed motors in case electricity is the source of power.

The bucket is usually of 10 gross tons capacity, its total spread when wide open enabling it to reach more than half way from the center of one hatch to the center of the other. The unloader leg also travels lengthwise of the hatch, so that the bucket reaches the sides of the boat. Consequently the operator is engaged to reach almost the entire cargo. In an ordinary ore carrying boat on the great lakes, there is no difficulty in reaching 90 per cent of the cargo, and in some of the modern boats machines have actually unloaded 97 per cent without the help of shovelers.

With slight modification it is claimed that they can be adapted for use in connection with the ordinary tramp ocean steamer to even better advantage than with the American boats. They will handle successfully, any kind of lump ore, digging through to bottom with surprising ease and rapidity.

When operating a number of machines on the same dock, it is customary to have several railroad tracks under the girders so that no delay may occur in supplying empty cars, in which case each machine is provided with a "bucket car" previously mentioned, which conveys the ore back to the

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second, third, or fourth track, or to stock pile, as desired. The legs which support the girders are ordinarily sufficiently separated to allow room for four tracks.

Where it is desired to put the ore into storage rather than into cars for direct shipment, cantilever extensions are built on the back end of girders inclined upwards as shown in photograph No. 4, taken at the plant of the Lackawanna Steel Co., Buffalo. These cantilevers carry a track for the bucket car, so that the ore can be conveyed by the bucket car out over the cantilevers and dumped into stock piles, as shown in photo above referred to which illustrates the bucket car dumping its load. The bucket car is automatic in its operation, dumping itself at any point desired on the cantilever and returning closed to its position under the hoppers, ready to receive another load.

The bucket operator who rides into the hatch and out over the dock with the bucket, controls all motions of the machine, except travel from hatch to hatch and operation of the bucket car, his position in the bucket enabling him to watch the work to the best advantage. Another operator controls the moving of the machine from hatch to hatch and also the operation of the bucket car. The machines are the invention of Mr. George H. Hulett and are manufactured by the Wellman-Seavers-Morgan Co. of Cleveland.

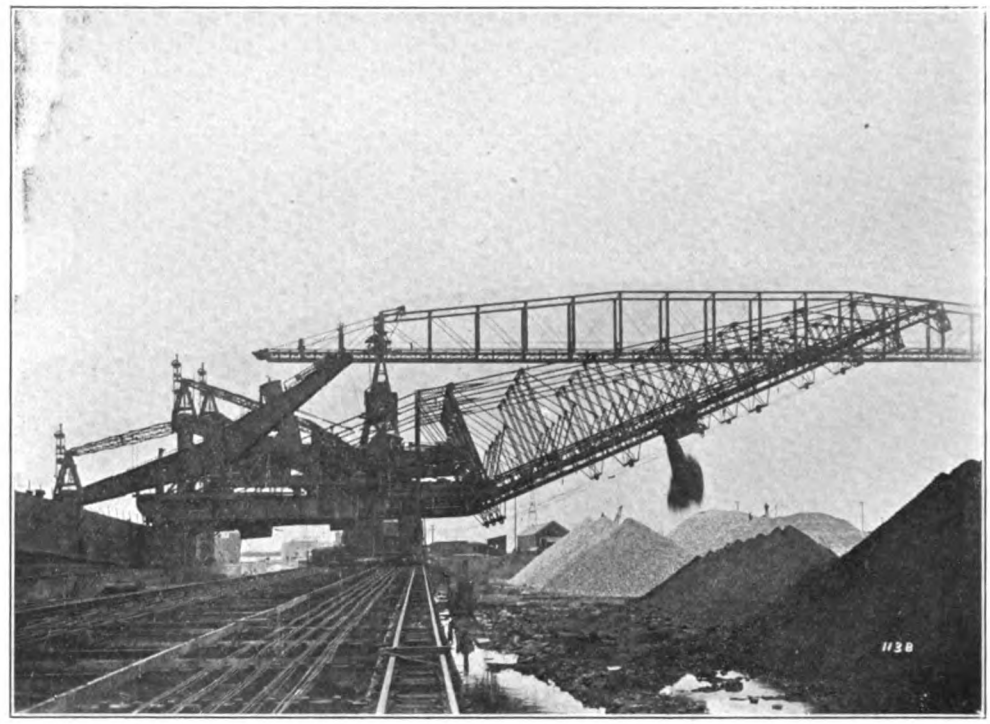

PHOTO NO. 4 SHOWS THREE OF THE FIVE HULETT AUTOMATIC ORE UNLOADERS AT LACKAWANNA STEEL CO.'S PLANT, BUFFALO. ONE UNLOADER IS SHOWN IN THE DOWN POSITION. PHOTO ALSO SHOWS BUCKET CAR DUMPING ITS LOAD.

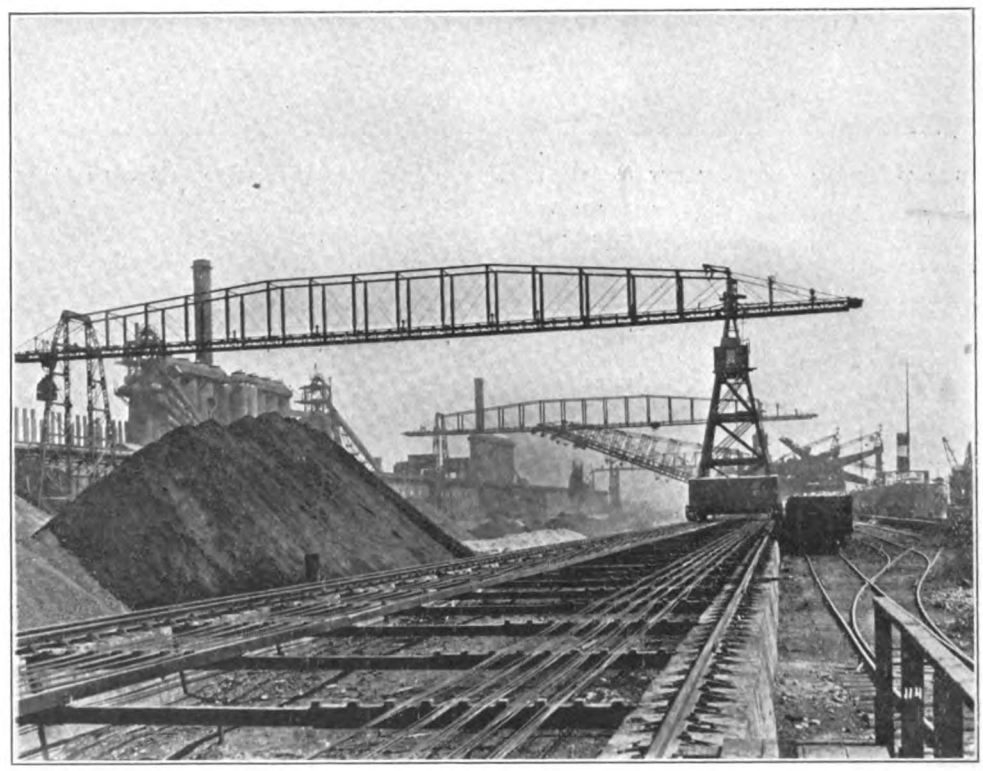

PHOTO NO. 5 SHOWING A VIEW OF THREE OF THE HULETT AUTOMATIC ORE UNLOADERS AT THE LACKAWANNA STEEL CO.'S PLANT, BUFFALO; ALSO TWO ORE STOCKING AND REHANDLING BRIDGES EQUIPPED WITH HULETT AUTOMATIC TWO-PART BUCKETS.

The Pittsburg Coal Dock Co. operating the Youghiogheny & Lehigh docks at Superior is preparing to increase the capacity of both docks and has let contracts for the work to the Wellman-Seaver-Morgan Co. The machinery plants are to be overhauled and rebuilt and the west end dock will be extended somewhat. The capacity of the east end dock will be doubled by improving the handling capacity.

The dredging and contracting firm of Whitney Bros. of Superior and Duluth, has bought frontage on Cumming slip, 900 ft. by 348 ft. deep, and will make it their headquarters for repairs and construction. The firm is branching out and expects to enter largely into a class of contracting it has not yet undertaken in a large way.

The Chicago, St. Paul, Minneapolis & Omaha elevator at Washburn, Wis., will be equipped with new sets of cleaners and sifters, as well as other machinery that will materially increase the grain handling capacity of the house. This elevator did a larger business the past year than previously and it is expected to

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still further increase this season. The house is operated by Nye, Jenks & Co. of Duluth. The bill for a Superior grain inspection has passed one house of the Wisconsin legislature and will doubtless pass the other when it comes up in regular course.

The Superior board of trade has elected these officers: President, W. R. Fanning; vice-presidents, M. E. Schouller, C. A. Erhart; directors for three years, F. R. Crumpton, M. P. Schmitt, T. J. Roth; board of arbitration and board of appeals were also elected.

APPOINTMENTS OF MASTERS AND ENGINEERS

Anchor Line, Erie & Western Trans. Co., Buffalo: Steamers—Juniata, Capt. Edward Martin, Engineer Wm. Wilson; Tionesta, Capt. John Doherty, Engineer John Wise; India, Capt Charles Christy, Engineer John Forrester; Japan, Capt. J. J. Lehan, Engineer Edward Stevenson; Muncy, Capt. Charles Nelson, Engineer F. Rehbaum; Corodus, Capt. L. Wright, Engineer T. Griffin; Mahoning, Capt. H. O. Miller, Engineer W. A. Black; Schuylkill, Capt. A. McKenzie, Engineer John Jordan; Susquehanna, Capt. H. Cronkhite, Engineer A. Edgar; Lehigh, Capt. F. Bloom, Engineer Wm. Garrity; Clarion, Capt. George J. Delaney, Engineer A. E. Welch; Alaska, Capt. Joseph Corcoran, Engineer John Healy; Conemaugh, Capt. M. Boggan, Engineer A. B. Fraser; Wissahickon, Capt. E. E. Loadwick, Engineer Charles Hull.

Northern Navigation Co. of Ontario, Ltd., Sarnia, Ont.; Steamers—Huronic, Capt. R. D. Foote, Engineer Samuel Brislin; Monarch, Capt E. Robertson, Engineer A. Morton; United Empire, Capt. A. L. Campbell, Engineer H. Myler; Majestic, Capt. George H. Playter, Engineer Wm. Whipps; City of Collingwood, Capt. A. M. Wright, Engineer C. Robertson; Germanic, Capt. W. G. Cox, Engineer Joseph Asten; City of Midland, Capt. F. G. Moles, Engineer Steve Burgess; City of Toronto, Capt. Paul Dusome Pentang, Engineer B. F. Osborne; Britannic, Capt. M. McLean, Engineer Isaac Boyd.

Pere Marquette Steamship Co., Milwaukee, Wis.: Steamers—Pere Marquette, Capt. W. J. Barnett, Ludington, Engineer James Meyers; Pere Marquette 16, Capt. George L. Thompson, Engineer George I. Van Brunt; Pere Marquette 17, Capt. Joseph Russell, Engineer A. W. Ackerman; Pere Marquette 18, Capt. Peter Kilty, Engineer C. Sylvester; Pere Marquette 19, Capt. Wm. La Fleur, Engineer J. C. Watson; Pere Marquette 20, Capt. J. C. Ackerman, Engineer Robert McLaren; Manistique, Marquette & Northern 1, Capt. W. P. Robertson, Engineer Joseph Taylor.

Midland Towing & Wrecking Co., Ltd., Midland, Ont.: Steamers—Traveler, Capt. James Tyndal, Engineer Frank Goodwin; Reliance, Capt. Roy Burke, Engineer James McGregor; Magnolia, Capt. Joseph Clark, Engineer John Doran; Metamora, Capt. Ed Burke, Engineer Fred Chester; Minitaga, Capt. George Kinnel, Engineer John Kinnel; Menodora, Capt. Charles Gould, Engineer Henry Chester.

St. Lawrence & Chicago Steam Nav. Co., Toronto, Can.: Steamers—W. D. Matthews, Capt. James Ewart, Engineer E. J. O'Dell; Iroquois, Capt. James McNaugh, Engineer Wm. Harwood; Algonquin, Capt. Wm. H. Wright, Engineer John W. Taylor; Rosedale, Capt. P. J. Shaw, Engineer James Findlay.

D. R. Hanna, mngr., Calumet Trans. Co., Cleveland; Steamers—George A. Flagg, Capt. A. McArthur, Engineer Wm. Miller; R. S. Warner, Capt. P. Millen, Engineer August Roemzick; Schooners—A. W. Thompson, Capt. M. Anderson; S. D. Warriner, Capt. W. A. Black.

Calvin Co., The, Garden Island, Ont.: Steamers—Simla, Capt. A. H. Malone, Engineer R. H. Veech; India, Capt. Charles Coons, Engineer T. C. Smith; D. D. Calvin, Capt. H. N. Smith, Engineer John Kennedy; schooners—Burma, Capt. J. Ferguson, Ceylon, Capt. J. Achee.

Grand Trunk Ry. Co., Windsor, Ont.: Car Ferries—Lansdown, Capt. F. D. Forrest and Capt. John Jackson, Engineer Joseph Taylor; Great Western, Capt. M. Bausetto and Capt. Baillargeon, Engineer Wm. Belson; Huron, Capt. Henry Oldenberg and Capt. O. Lalonde, Engineer Joseph Ladds.

Lake Michigan Car Ferry & Trans. Co., Chicago: Steamers S. M. Fischer, Capt. Fred Johnson, Engineer Bert Rasch; J. C. Ames, Capt. W. H. Welcher, Engineer J. Phillips; Car Ferry No. 1, Capt. A. H. Bohlin; Car Ferry No. 2, Capt. Wm. Chambers.

Kinsman Transit Co., Cleveland: Steamers—Henry Steinbrenner, Capt. Harry Gunderson, Engineer Otto E. Hoffman; Anna C. Minch, Capt. L. C. Cummings, Engineer C. R. Price; Philip Minch, Capt. Joseph Lampoh, Engineer W. H. Miller.

Lozen, Capt. J. B., New Baltimore Mich.: Steamer—Charles A. Street, Capt. J. T. Hanson, Engineer Charles Flanaghan. Schooners—J. B. Lozen, Capt. J. F. Lozen; J. Godfrey, Capt. Richard Moore.

E. McFall, mgr. Sandusky & Islands and Sandusky & Peninsular Steamship Co., Sandusky, O.: Steamers—Arrow, Capt. George A. Brown, Engineer Jacob Wies; Lake Side, Capt. Fred J. Nagle, Engineer Wm. Quick.

Cranage, S. P., Bay City, Mich.: Steamers—Thomas Cranage, Capt. John S. McNeil, Engineer Wm. Nerreter; City of Paris, Capt. Washington Moore, Engineer Daniel W. Humphrey.

West Division Steamship Co., Chicago: Steamers—Fred Pabst, Capt. D. C. Sullivar · W. H. Wolf, Capt. J. O. Loleau, Engineer W. Reardon; schooner Armenia, Capt. George M. Dennis.

Marine Navigation Co., Michigan City, Ind.: Steamers—Francis Hinton, Capt. John N. Campbell, Engineer Rolph Zeitsch; A. R. Colborn, Capt. Odin Larsen, Engineer John H. Lutz.

L. R. Boynton, mgr. Island Trans. Co., St. Ignace, Mich.: Steamers—Algomah, Capt. G. W. Boynton, Engineer R. McLaughlin; Wau-Kon, Capt. A. Graves, Engineer George Densmore.

La Croix, Gilbert, Mt. Clemens, Mich.: Steamer D. D. Hayward, Capt. Joseph Inches, Engineer George Tromble; Mascotte, Capt. Gilbert La Croix, Engineer Charles Burnham.

Midland Navigation Co., Midland, Ont.: Steamers—Midland King, Capt. W. H. Feathertonbaugh, Engineer Ed. Abbey; Midland Queen, Capt. Frank Burke.

Cummings, M. J., Oswego, N. Y.: Steamer Western Star, Capt. P. J. Griffin, Engineer Martin Griffin; C. S. Parnell, Capt. Wm. Griffin, Engineer S. Mallen.

Recor, E. C., St. Clair, Mich.: Steamer E. P. Recor, Capt. E. Hungerford, Engineer C. Schunk.

Lonsley, Chas., Mt. Clemens, Mich.: Steamers Ida E., Capt. H. D. Moore, Engineer George Robertson; Clinton, Capt. Daniel West, Engineer John Hibbard.

Warde, John J., Chicago: Steamer Niko, Capt. Thomas Beggs, Engineer John Collins; schooner Annie M. Peterson, Capt. Charles Bough.

McVittie, Alex., Detroit: Steamers—Senator, Capt. W. A. Irvine, Engineer W. J. Bolton; Colonel, Capt. A. Ames, Engineer A. Cobo.

Central Canada Coal Co., Ltd., Brockville, Ont.: Steamer Samuel Marshall, Capt. John Bouchard, Engineer Henry Cerow.

Canadian Northwest Steamship Co., Ltd., Toronto, Can.: Steamer Neebing, Capt. John Ewart, Engineer A. F. Foote.

Wallace & Cunningham Transit Co., Detroit: Steamer W. B. Morley, Capt. John McAlpin, Engineer Charles Monroe.

Charlevoix Lumber Co., Charlevoix, Mich.: Steamer Pine Lake, Capt. George Weaver, Engineer Harvey Campbell.

Ellis, Charles H., managing owner, Milwaukee: Steamer Hilton, Capt. Manning Kilton, Engineer Stephen Tessar.

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STEEL CORPORATION'S FLEET

The Pittsburg Steamship Co., in disposing of sixteen of its smaller class of vessels has increased the average carrying capacity of its entire fleet from 4,563 gross tons to 5,136 gross tons, or an average of 568 tons per vessel. These figures include the four great steamers now building. Of these vessels, sixty-one are of 5,000 tons carrying capacity and over, five are between 4,000 and 5,000 tons, twenty-four are between 3,000 and 4,000 tons and ten are under 3,000 tons. Their combined carrying capacity for a single trip, based upon their actual bills of lading, is 513,651 tons. In a season of twenty trips the fleet could carry 10,273,020 tons. This is safely more than the maximum carrying capacity of the fleet for the season of 1905, because the four great freighters, which have a combined carrying capacity of 40,000 tons per trip, or 800,000 tons for the season, will not be ready in time to do a full season's work this year.

With the average carrying capacity of the Pittsburg Steamship Co.'s fleet fixed at 5,136 tons, some interesting conclusions can be drawn. It occupies neither first nor second nor third nor fourth places in average carrying capacity. The first place is occupied by Mr. Tomlinson's fleet, with an average carrying capacity of 7,276 gross tons; second place by Mr. Henry A. Hawgood's fleet with 6,340 tons; third place by Mitchell & Co.'s fleet with 5,153 tons, and the fourth place by Mr. W. A. Hawgood's fleet with 5,169 tons. The great element of strength of course in the Steel Corporation's fleet is the fact that it has sixty-one vessels of between 5,000 and 7,000 tons, their average carrying capacity being 6,310 tons. It can be readily appreciated, however, from these general figures, that it will have to undergo an extensive ship building program before it can really take first place in average carrying capacity on the great lakes. The Steel Corporation is the largest shipper and ship owner on the great lakes, but its real interest is that of the shipper. Its concern is to get its ore from the mines to the furnaces as economically as possible. It is in the shipping business primarily for protective reasons, but naturally it desires to make ship owning profitable and appreciates the economy of the large carrier. The ship yards of the great lakes may therefore expect orders for large carriers from this source as time goes on. The financial returns clearly show that the ore trade belongs to the larger carrier and the problem what to do with the smaller class of vessels is doubtless one which is concerning the Steel Corporation quite as much as any other interest. If the rest of its smaller class of vessels could be sent to the coast it would doubtless send them there, but it has disposed of all that could go through the canals. There is little money in the ore trade for the steel freighter of moderate dimensions. The following table of the carrying capacity of the various vessels of the steel corporation's fleet, brought up to date, will prove of interest:

OVER 5 000 TONS

Name of Vessel.	Gross Tons.	Name of Vessel.	Gross Tons.
Wm. E. Corey	10,000	Murphy	6,829
H. C. Frick	10,000	Poe	7,027
A. H. Gary	10,000	Princeton	6,423
G. W. Perkins	10,000	Queen City	5,598
Bessemer	5,459	Rensselaer	6,748
Black	6,021	Shaw	6,900
Bunsen	6,632	Siemens	5,461
Coralia	5,331	Stephenson	5,558
Cornell	6,499	Superior City	6,588
Crescent City	5,705	Van Hise	6,557
Edenborn	7,074	Watt	5,508
Ellwood	7,282	Zenith City	5,098
Empire City	5,672	Bryn Mawr	6,725
Ericsson	5,357	Carrington	5,260
Fairbau	5,288	Corliss	5,320
Fulton	5,411	Fritz	7,054
Gates	7,031	Holley	5,309
Harvard	6,628	Jenney	5,254
Hill	7,010	Krupp	5,143
Houghton	5,842	Martha	5,149
Lafayette	6,588	Magna	5,262
Linn	5,535	Maida	5,627
Maricopa	5,464	Maia	5,992
Mataafa	6,313	Manila	7,019
Maunaloa	6,000	Madeira	6,999
Mahetoa	6,756	Marsala	7,012
McDougall	6,276	Nasmyth	5,272
Manda	5,145	Roebling	6,890
Hoyt	5,500	Smeaton	7,192
Bell	5,500	Thomas	5,223
Morse	6,385	Total	385,646

ABOVE 4,000 AND UNDER 5,000 TONS.

Name of Vessel.	Gross Tons.	Name of Vessel.	Gross Tons.
Eads	4,716	Mariposa	4,074
Maritana	4,145	137	4,916
Rockefeller	4,648	Total	22,499

ABOVE 3,000 AND UNDER 4,000 TONS.

Name of Vessel.	Gross Tons.	Name of Vessel.	Gross Tons.
Briton	3,124	Roman	3,080
Corona	3,108	Saxon	3,050
Corsica	3,100	Trevor	3,118
German	3,134	118	3,196
Gilbert	3,825	130	3,120
Grecian	3,255	131	3,136
Manola	3,003	132	3,100
Mariska	3,110	133	3,127
Maruba	3,243	134	3,106
Matoa	3,040	Malta	3,984
Marina	3,037	Marcia	3,978
Mather	3,274	Total	77,607
Neilson	3,359		

UNDER 3,000 TONS.

Name of Vessel.	Gross Tons.	Name of Vessel.	Gross Tons.
Cambria	2,900	Palmer	2,600
Cort	2,998	111	2,779
Griffin	2,650	Wawatam	2,671
Joliet	2,850	Wolvin	2,757
La Salle	2,700	Total	27,899
Masaba	2,994		

GETTING LAKE ERIE DOCKS INTO SHAPE

The docks will be in excellent shape by the opening of navigation to care for the ore trade. All the ore on dock was practically sold some time ago and has been moving forward freely to the furnaces. Weather conditions have been very favorable lately and the movement of ore has been but little interrupted. It will be especially heavy during March. Meanwhile the dock companies are generally improving their equipment. M. A. Hanna & Co. are making some alterations in the clam shell buckets at the Cleveland & Pittsburg ore dock in Cleveland which will facilitate their operation. They are also installing two big McMyler conveyors with clam shell unloaders at the Buffalo Union furnace, Buffalo. These machines will have a capacity of 150 tons per hour each. Two revolving cranes with clam shell buckets are being installed on the Philadelphia & Erie Ry. Co.'s dock at Erie by the McMyler Manufacturing Co. and it is probable that a third one will be shortly added. Their capacity is 100 tons per hour each. M. A. Hanna & Co. are also adding to the electrical power of the machines on the Pennsylvania docks at Ashtabula. The Pittsburg Coal Co. is installing a McMyler car dump at Fairport with a capacity of handling thirty cars per hour, equivalent to loading 1,500 tons per hour.

The dock companies realize that certainly so far as the first half of the year is concerned they will be called upon to make extraordinary efforts to handle the flow of ore and are preparing to do so.

The steamer James C. Wallace, building at the Lorain yard of the American Ship Building Co. for the Acme Steamship Co. of Duluth, will be launched March 9. This steamer is 552 ft. over all, 532 ft. keel, 56 ft. beam and 31 ft. deep. She has triple-expansion engines and Babcock & Wilcox boilers. Her dimensions are but slightly less than those of the Wolvin and Mr. A. B. Wolvin, who is a great admirer of Mr. Wallace, decided to name the steamer after the president of the American Ship Building Co.

The steamer Castalia, belonging to the Brown Steamship Co., will be lengthened 92 ft. at the Cleveland yard of the American Ship Building Co. The Castalia is 292 ft. keel and 40 ft. beam and was built in 1890. When altered she will be 364 ft. keel and her carrying capacity increased from 3,300 to 4,800 gross tons.

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EARNINGS AT SMALLER PERCENTAGE

Buffalo, Feb. 28.—There is any amount of evidence all through the lake trade of a general conviction that earnings on the part of the fleet are hereafter going to be at a smaller percentage than at any time in the previous history of the trade. There is all along the line a steady and more or less concerted effort to make good this falling off by cutting off something else that stood for expense, and it is this state of things that makes it likely that the vessel interest will in some way make another stand against the encroachments of the unions, which of course, are always in the line of increased running expenses.

The unions must take care or they will kill the goose that lays, perhaps not a solid golden egg, but some sort of a supporting egg, in their nest. Here is an instance: When the heads of the tugmen's union left here for the last conference with the heads of the towing company it was whispered with some glee by their friends, who may not have been quite so friendly with the company, that they were to make demands for more hours off and more tugs at various ports. The program was carried out and the conference was broken off at that point.

For the managers of the tug line plainly told the tugmen that the demand for every second night and second Sunday off in place of third was to put the company out of business. The tug business fell off $141,000 last year, apparently on account of the disposition of the big steamers to make their docks and their shifts without assistance, all in the one line of effort to cut down expenses. It would take sixteen extra tugs to make up the hole in the work demanded by the tugmen and would increase the daily cost per tug $42.03 and entail a loss on the business. These figures were shown the tugmen at the conference. They were rather hastily made up, but a careful revision of them shows that the estimate is too low rather than too high. It was this that obliged the management to throw up its hands and say that there must be some modification of the demand or the tugs might just as well tie up at the outset of the season.

So it goes in all departments of the lake trade. There are remarks that when Buffalo used to have two tug lines there were sixteen tugs maintained, while the number now is only about nine, with consequently some complaint of insufficient service. Things are different now from the conditions of ten years ago and there is no indication that former conditions will ever return. Of course this brings out talent and stimulates it to devise ways of making a profit in spite of the changes. Nothing develops invention like need, and it is found that the effort to cut down everything that tends to hold a vessel in port is not only active, but is accomplishing something. There is certainly a good margin to work on.

Not long ago our vesselmen were going to the coast and returning puffed up with pride. They saw cargoes coming out or going into vessels at a rate that took days fairly where only hours would be consumed here. But these cargoes were often weeks afloat to days with us and the time ashore was often needed to look after the vessel. Of late, though, there has been much less said about fast handling, especially of ore, and now there is plenty of complaint that some of the fleet has been making only twelve trips a season, when with dispatch at both ends they might easily have made twenty.

This is a mighty difference, especially when the discharge of crew in the meantime is not permitted. The lumber fleet is making the very same complaint, but that comes merely from the stevedore interest being on the line of keeping the men at work and so not providing for the bunching of the fleet. It comes in also from the paying of a poor man as much as a good one, and so most of them are poor.

But the ore interests are now largely identical with the vessel-owner interests and here is a splendid spur to effort at faster handling. The new plan of providing storage plants at the discharging docks, even when the furnace is at hand, is a move in the right direction, so that the dock with only car capacity is not going to be used long except occasionally. Then a further improvement of the appliances for picking up ore from a pile and it will be proper to unload to a pile, even if the ore is to be used in a few days.

It would be interesting to learn where all this rush towards greatest efficiency at least cost would end and whether it can ever end at all. Already the consumer is reaping a benefit that is simply enormous, as compared with but a few years ago. If he were inclined to be content with the acquirement of fifty years ago it would all be easy, but his wants go on faster than all inventions can provide.

JOHN CHAMBERLIN.

STOCKS OF GRAIN NOT HEAVY

Duluth, Minn., Feb. 28.—Stocks of grain are increasing very slowly here now, and it is not probable that they will be very much in excess of 18,000,000 bu. at the opening of navigation. There is no indication of any large proportion of this going forward at once. The opening rate on wheat is now expected to be 2½ cents a bushel. Ice conditions on Lake Superior are encouraging for an early opening of navigation. There is now no ice more than 18 miles out from the head of the lakes, and it is said not to be very widespread at the eastern end. Two Harbors, 26 miles down the north shore, is free from ice, and the solid field does not appear very heavy. There is no appearance of any trouble in the ranks of vessel labor except among the mates, and the attitude of captains is such as to preclude the possibility of any serious difficulty from mates. All the vessel interests are ready for an early opening and most of them want it.

Cars for all-rail shipments of flour and grain from the head of the lakes are hard to get, indeed some of the roads report what is virtually a car famine. The Northern Pacific and Great Northern roads are moving from the head of the lakes about 300 cars a day of coal alone and shippers are in trouble to get rolling stock that can be moved off the road's own lines. The shipments of wheat would be considerably larger now if there were cars, and one lot of about 30,000 bu. is held up here on that account. Flax shipments exceeded receipts last week by 22,000 bu.

SUGGESTED MOVABLE DAM AT THE SAULT

General O. H. Ernst of Chicago, Major W. L. Sibert of Pittsburg and Major J. G. Warren of Milwaukee, government engineers, met at Detroit last week to pass upon plans which have been proposed for the construction of a movable dam above the upper gates of St. Mary's Falls canal. Some twenty-two plans in all were considered and the engineers, who constitute a special commission upon this subject, will meet again at the Sault early in May. The project of a movable dam is to construct a safeguard above the lock gates for emergency purposes should anything happen to the gates themselves. The object is to prevent a rush of water through the locks which would make it impossible to manipulate the present gates, which are operated now only in still water. Nothing of the sort has ever happened, of course, the proposed dam being merely to provide for an emergency.

The American Canvas and Tarpaulin Corporation, 45 North Division street, Buffalo, has been organized to manufacture anything in canvas. Mr. F. R. Paradis, for years superintendent of Howard H. Baker & Co.'s canvas department, will have charge of the manufacturing end of the business and will be vice president and manager of the corporation. Mr. James E. Shaw is president and treasurer. The corporation has installed the largest modern machines for manufacturing everything in canvas.

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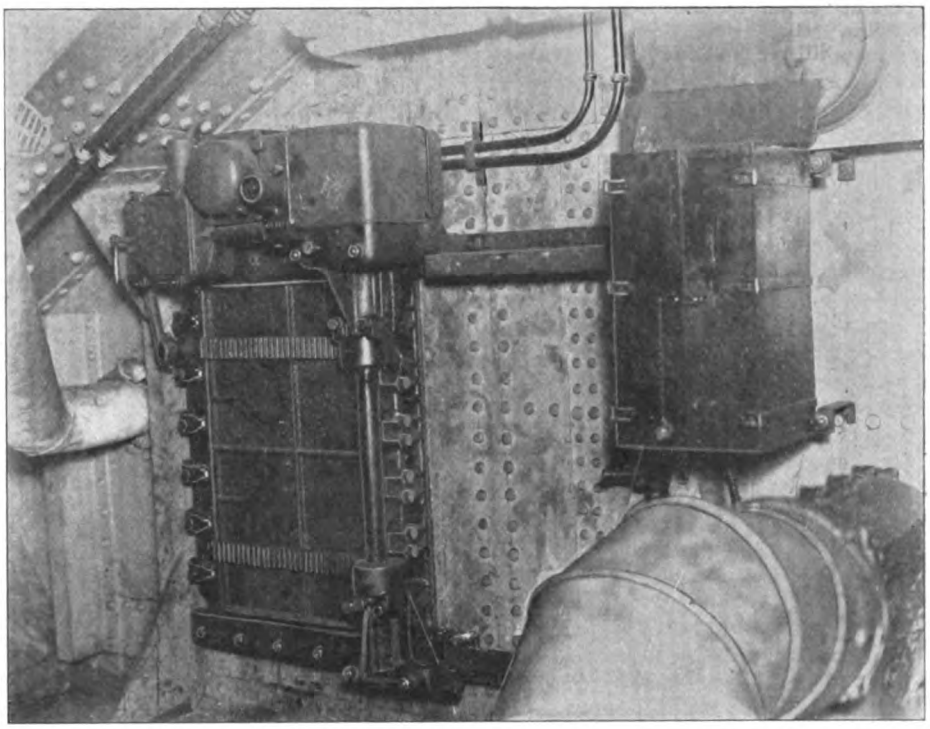
CLOSING BULKHEAD DOORS BY ELECTRICITY

After several years of costly experimentation with pneumatic and hydraulic systems for operating bulkhead doors and armored hatches aboard warships, both systems have been abandoned by the American navy in favor of an electrical system. The first electrical installations are now in working order on the Colorado and Pennsylvania, the new 13,500-ton armored cruisers. Thirteen other cruisers and battleships now building will be similarly equipped.



HORIZONTAL DOOR LONG-ARM SYSTEM ON THE UNITED STATES ARMORED CRUISER COLORADO.

The defects developed in the hydraulic and pneumatic systems—due mainly to the practical impossibility of keeping their valves and packings in working order—have been overcome in the electric system, and naval authorities, including many who have heretofore opposed, as necessarily ineffective, all power doors for bulkheads, have given the new "Long Arm" electrical system unqualified approval. The bad repute into which distinctly controlled bulkhead doors fell at one time was brought about by the members of the crew who were likely to suffer from the operation of the power system. The first idea was to drop the heavy doors like so many guillotines, then followed the idea of closing doors slowly by air or water pressure. But in both cases it was found that the doors could not be depended upon to shut at the right moment, nor to stay open when so required, because the pneumatic and hydraulic pressure could not be perfectly maintained.

The electrical system, however, is not subject to these defects. It complies in every way with the specifications of the navy department providing that power doors or armor hatches "must be capable of permitting operation on the spot by power or by hand from either side of the bulkhead or deck," and "be capable of being closed by power, simultaneously from an emergency station." It is further provided that when the doors are closed and the emergency is on any door may be opened by a man at the door to allow him to pass through in performing his duties, but after he has passed through and released the controller handle the door will again close by the emergency action.

The mechanism of the "Long Arm" system may be outlined as follows:

(1) An emergency station, located usually in the pilot house or some convenient place above the deck.

(2) The power doors or hatch-gears, supplied with three independent mechanisms.

(a) The switch by which a man at any door can open and close it at will from either side.

(b) The switch, operated from the emergency station, by which the door is closed upon the approach of danger. This emergency switch, although permitting absolute control, may have its operation suspended temporarily by the hand switch just mentioned. In such a case the emergency station switch will close the door, as soon as the hand controller is released.

(c) The limit switch, by means of which the current supplying the motor which provides the power for closing and opening the doors, is cut off when the door has closed and locked, or has encountered an obstacle to full closure. This switch has mechanical connection with the door or hatch-plate and is so arranged that it will cut off the current from the motor, and thus prevent blowing out of the fuses. An interesting improvement of this part of the mechanism is one by which the switch is made to again close the circuit to the motor and thus start the door toward its grooves after an obstruction is removed, e. g., when an inflow of water washes away coal obstructing a bunker opening.

The door and hatch gear motors are direct current, reversible, iron-clad, bi-polar, of light and compact construction for intermittent service. They are entirely enclosed in watertight cases. They are capable of carrying large overloads without heating or injury.

The emergency station consists of two parts, one a watertight case containing the mechanism for controlling the circuit running to each door or hatch gear for closing the same, and the lamps to indicate the closure; the other case containing the fuse box, in which each wire is supplied with the proper fuse.

The wiring required for a complete installation of the system is very simple. It comprises one twin conductor by which the emergency station is connected with the ship's mains; one twin conductor by which the controller on each door and hatch gear is connected with the emergency station, and one twin conductor connecting the controller on each hatch gear or door with the ship's mains. Here, as in other parts of the system, great simplification has been worked by replacing pneumatic and hydraulic power by electricity. The latter added another set of complicated machinery to the ship's equipment, while the electric system calls for nothing more complicated than connection with the electrical mains necessary for other purposes.

To explain the operation of the "Long Arm" system it is perhaps best to imagine an actual instance in which it would be called into play. Suppose that the Colorado is in danger of being rammed, or that her hull has been punctured by a torpedo. The officer of the deck or the one first aware of the danger will "press the button" of the emergency station, immediately releasing the gearing driven by a spring and controlled by an adequate escapement. This gearing then closes the circuit for operating the emergency switch in the controller of each door or hatch-gear. It does not start all the motors at the same time, thus avoiding the necessity for a large supply of current. It starts the doors one after the other at intervals of about three seconds, so that twenty-five doors and hatch-gears can be closed in 75 seconds from each emergency

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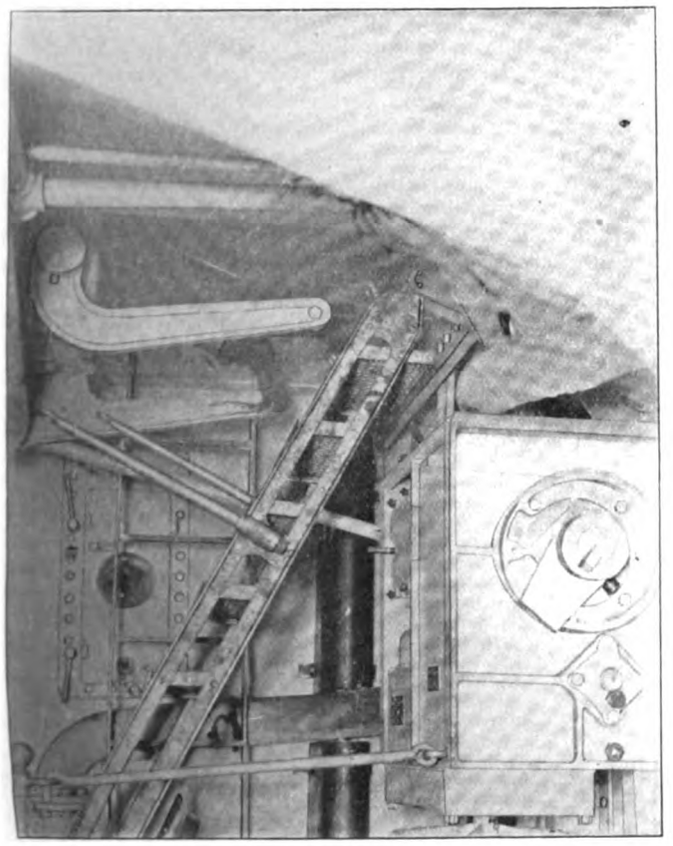
station without more than six motors being in operation at any one time.

As each door makes a complete closure it automatically completes the circuit running to the emergency station and is there connected with a small incandescent lamp, located back of each of the discs around the edge of the emergency station. Each disc is numbered to correspond to a door, so that the officer in charge can tell by a glance at the station whether or not all the doors have been closed. If any one door or hatch-plate has not closed, the fact is immediately observable, and the location of the trouble is known by reference to a diagram at hand showing the location of all the power doors and hatchways. Whether the emergency is "on" or "off" is indicated by a red light shining through one of the lower discs of the station.

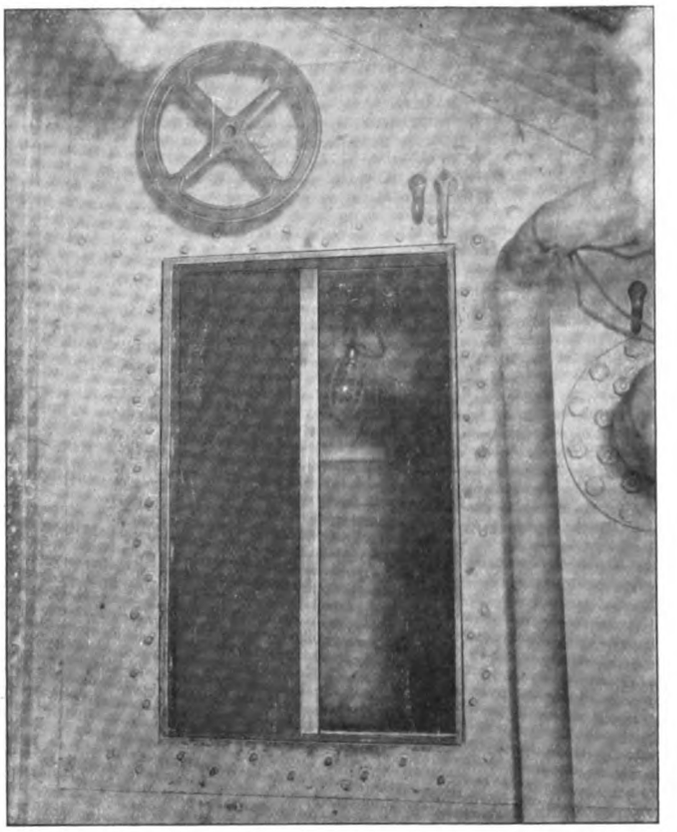
The navy department has subjected this system to the severest possible tests before approving it. The results of these tests are shown in the fact that similar equipment is called for in the specifications for all three of the men-of-war just authorized by the United States government. The principal feature which has excited the approval of practical naval officers is that this device secures the confidence of the members of the crew stationed in the immediate vicinity of the power doors, the same men who had so little confidence in the hydraulic and pneumatic systems that they invariably tampered with the mechanism in such a way as to defeat its purpose completely. The combination of perfect local control with the certainty which the electrical system gives that the doors will not suddenly drop, mainly accounts for this confidence.

The question of power doors is receiving attention by the admiralty department of almost every important government in the world. The fact that H. M. S. Victoria might have been



HATCH CLOSED WITH GEAR, LONG ARM SYSTEM ON UNITED STATES ARMORED CRUISER COLORADO.

saved if her bulkhead doors had been closed has been ever in the minds of progressive naval constructors. Owing to the fact that nothing has been devised abroad better than clumsy imitations of the old hydraulic and pneumatic installations on American warships, now discarded by the American navy itself, accounts for the fact that foreign navies have not yet seen



HORIZONTAL DOOR, BACK VIEW, PART OPEN, WHEEL ON, LONG ARM SYSTEM, ON UNITED STATES ARMORED CRUISER COLORADO.

fit to call for power doors in the equipment of their new ships. It is likely, however, that several European battleships will be equipped with the "Long Arm" apparatus within a short time.

The fact is being appreciated by the best builders that it pays to protect woodwork from decay. The United States engineer is using two coats of hot carbolineum on all wood fenders which are fastened on piers in the port of Cleveland. Capt. N. Simonson of the American Construction Co., who is building a fine 65-ft. scow at Cleveland, is treating all wood with a coat of the carbolineum and he expects to paint over it in the standard color. The 11,000 ft. of Georgia pine planking used to form the rolling road, which is in operation on Factory street hill, Cleveland, was all immersed in a hot solution of this material and it required only 80 gallons to thoroughly treat it. In this case the fact that it prevents ice from adhering to the plank makes it doubly valuable. Several of the progressive architects are now using carbolineum for porch construction as well as for shingles. It is like burning money to use untreated timber any place where it might decay when the life of a stick can be doubled at about one-fifth its cost. Its use means a saving of 400 per cent on the cost of the carbolineum. Mr. C. H. Hoyt, Osborn building, Cleveland, will be glad to furnish the material or any further data concerning it.

Nearly a dozen squares of modern wharves and freight sheds, two magnificent grain elevators, hundreds of loaded cars and vast quantities of freight were destroyed at New Orleans last week by fire. The Illinois Central terminals in the river, known as the Stuyvesant docks, were wiped out.

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PRESIDENT ROOSEVELT ON OUR NAVY

The commemoration of Washington's birthday by the University of Pennsylvania was made notable by an address by President Roosevelt upon the wisdom of building up a great navy. He said:

"Among Washington's maxims which he bequeathed to his countrymen were the two following: 'Observe good faith and justice toward all nations,' and 'to be prepared for war is the most effective means to promote peace.' These two principles taken together should form the basis of our whole foreign policy. Neither is sufficient taken by itself. It is not merely an idle dream, but a most mischievous dream, to believe that mere refraining from wrong doing will insure us against being wronged. Yet, on the other hand, a nation prepared for war is a menace to mankind unless the national purpose is to treat other nations with good faith and justice. In any community it is neither the conscientious man who is a craven at heart nor yet the bold and strong man without the moral sense who is of real use to the community; it is the man who to strength and courage adds a realizing sense of the moral obligation resting upon him, the man who has not only the desire but the power to do his full duty by his neighbor and by the state. So, in the world at large, the nation which is of use in the progress of mankind is that nation which combines strength of character, force of character and insistence upon its own rights, with a full acknowledgment of its own duties towards others. Just at present the best way in which we can show that our loyalty to the teachings of Washington is a loyalty of the heart and not of the lips only is to see to it that the work of building up our navy goes steadily on, and that at the same time our stand for international righteousness is clear and emphatic.

"Never since the beginning of our country's history has the navy been used in an unjust war. Never has it failed to render great and sometimes vital service to the republic. It has not been too strong for our good, though often not strong enough to do all the good it should have done. Our possession of the Philippines, our interest in the trade of the orient, our building the Isthmian canal, our insistence upon the Monroe doctrine, all demand that our navy shall be of adequate size and for its size of unsurpassed efficiency. If it is strong enough I believe it will minimize the chance of our being drawn into foreign war. If we let it run down it is as certain as the day that sooner or later we shall have to choose between a probably disastrous foreign war or a peace kept on terms that imply national humiliation.

"Our navy is the surest guaranty of peace and the cheapest insurance against war, and those who, in whatever capacity, have helped to build it up during the past twenty years have been in good faith observing and living up to one of the most important of the principles which Washington laid down for the guidance of his countrymen. Nor was Washington the only one of our great presidents who showed far-sighted patriotism by support of the navy. When Andrew Jackson was in congress he voted for the first warships we ever built as part of our regular navy, and he voted against the grant of money to pay our humiliating tribute to the pirates of the Barbary states. Old Hickory was a patriot through and through, and there was not an ounce of timidity in his nature, and, of course, he felt only indignant contempt for a policy which purchased an ignoble peace by cowardice instead of exacting a just peace by showing we were as little willing to submit to as to inflict aggression. Had a majority of Jackson's colleagues and successors felt as he did about the navy, had it been built up instead of being brought to a standstill, it would probably never have been necessary to fight the war of 1812."

Mr. W. J. Harsant has been appointed assistant chief engineer of the Pittsburg Steamship Co.'s fleet of vessels.

SEA LEVEL CANAL RECOMMENDED

The first definite engineering plans for the construction of the Panama canal have just been laid before the Isthmian canal commission by the engineering committee of that body, consisting of Commissioners Burr, Parsons and Davis. The principal recommendations are summed up in this resolution:

"Resolved that this committee approve and recommend for adoption by the commission a plan for a sea level canal, with a bottom width of 150 ft., and a minimum depth of water of 35 ft., and with twin tidal locks at Maraflores, whose usable dimensions shall be 1,000 ft. long and 100 ft. wide, at a total estimated cost of $230,500,000. Such estimate includes an allowance for engineers, sanitation and contingencies, amounting to $38,450,000, but without allowance for interest during construction, expense of zone government and collateral costs, and water supply, sewers, or paving of Panama or Colon, which last items are to be repaid by the inhabitants of those cities."

The committee estimates that a sea level canal can be completed within from ten to twelve years from the present time. These recommendations are the conclusion of a report to the commission prepared in the canal zone under date of Feb. 14 last and based on complete engineering reports on all of the problems involved.

It is recommended that the Chagres river be controlled by a dam at Gamboa, built to a crest height of 200 ft., and the waters of the lake thus created disposed of through tunnels. Work on the foundation of the dam will require from one to one and a half years and, the committee reports, should begin at once.

Actual work with the new American steam shovels in the Culebra cut has demonstrated that the entire excavation can be done at a cost of 50 cents a cubic yard. The former Isthmian canal commission estimated this cost at 80 cents. This reduction amounts to a total of $15,000,000, and is given as a justification for the recommendation for a sea level canal.

"These considerations have induced this committee to express to the committee its unanimous judgment that with the contemplated system of working, and with the rate of development which appears to be justified by the work now being performed at Culebra, a sea level canal, free from the restriction of locks, should be adopted. This committee believes that such a canal, with terminal harbors, can be constructed for a sum not exceeding $230,500,000.

"The advantages of a sea level canal across the isthmus are most obvious. It would be a waterway with no restriction to navigation and which could easily be enlarged by widening or deepening at any time in the future, to accommodate an increased traffic, without any inconvenience to the shipping using it, whereas a lock canal is in reality a permanent restriction to the volume of traffic and size of ships that use it. Although it is possible to design and construct locks adapted to the future transformation to a sea level canal, that transformation cannot be made without serious inconvenience to navigation and at a cost so great as to be excessive. The additional cost of a sea level canal over that of a canal with locks, with a summit level of 60 ft. above mean tide, is $52,462,200, or $79,742,000 more than the estimated cost of the lock canal with a summit level 85 ft. above mean tide, proposed by the former Isthmian canal commission, after allowing $6,500,000 for the Colon breakwater and direct entrance not previously estimated. This committee considers this additional expenditure fully justified by the advantages secured."

The pilots of San Francisco are strenuously opposing the bill proposed in congress to transfer the control of the pilotage service from the state of California to the United States inspection bureau. They endeavored to get the support of the chamber of commerce, but this body, after hearing the report of its committee on harbors and shipping, unanimously decided not to favor the opposition of the pilots.

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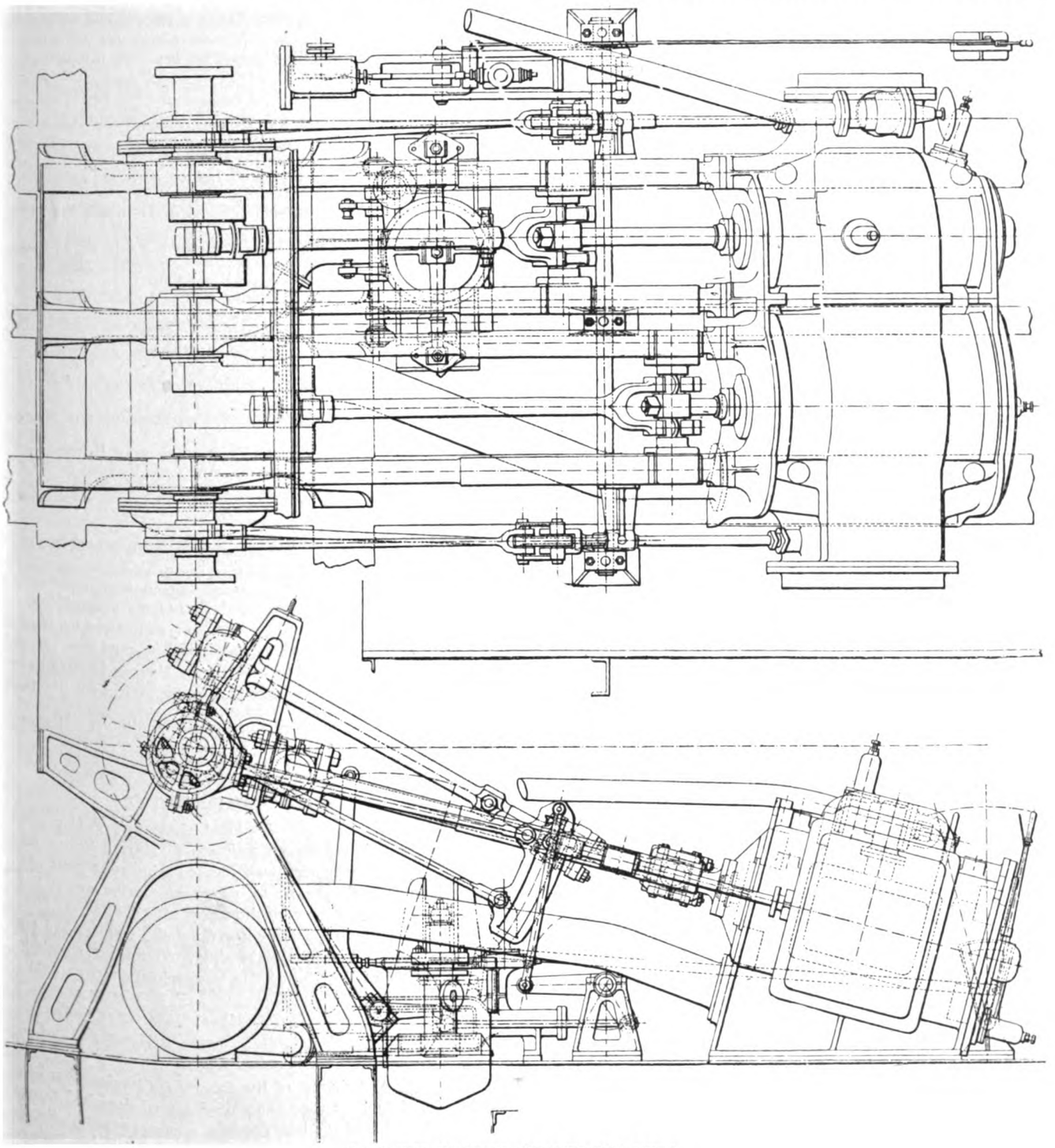
ENGINES FOR RIVER THAMES STEAMERS

Through the courtesy of the Thames Iron Co., the Engineer, London, England, has published the plan and side elevation of the engines to be fitted in the new steamer intended for passenger service on the River Thames between Greenwich and Hammersmith. Premising that these vessels are to be 130 ft. long, 16 ft. 6 in. beam, and 2 ft. 10 in. draught when loaded, and their intended working speed at that draught 12 statute miles per hour, the motive power to attain that speed in regular service is to be obtained in each vessel by an engine—as shown in the illustration—of the diagonal two-cylinder compound type, driving a pair of paddle-wheels, 10 ft. 6 in. diameter over the floats; the cylinders being 16 in. and 31 in. diameter by 2 ft. 6 in. stroke; the working pressure is to be 115 lbs.; and the engines, when running at a speed of 55 revolutions a minute, are expected to develop 270 I. H. P.

The engine, it will be seen, consists of three A-shaped cast iron frames carrying the main crankshaft bearings, the frames being securely bolted at their feet to seatings worked up from the vessel's frames, and at their heads to the sponson beams as usual. The cylinders are placed as shown, in an inclined position forward of the paddle shaft, the high-pressure being on the port side of the vessel; the piston-rod guide bars, which are of forged steel, on both cylinders forming the connections between them and the main bearing frames. The main crank shaft is of wrought steel 6¾ in. diameter, forged in one piece,



COMPOUND ENGINES, THAMES STEAMERS.

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having a coupling flange at each end as shown for connecting up to the paddle-wheel shafts, which are also of steel.

The surface condenser, which is cylindrical in form and of light construction, is placed athwartships as shown, between the legs of the main bearing frames, its shell being built of Muntz metal plates riveted together and joints sweated, and its water ends of copper; the tubes, which are of brass, will be fitted into the tube plates with screwed glands and tape packing. The cooling water is supplied by an independent centrifugal circulating pump, a small auxiliary air pump being driven off the same engine. The main air pump, which is of the Edwards type, and which will be seen in the plan and side elevation, is placed aft of but on the center line of the high-pressure cylinder, is driven by link and lever gear off the high-pressure connecting-rod, the feed and bilge pumps being also actuated by the same gear. The paddle-wheels, which are of the feathering type, have arms and rims of wrought iron, the wheel bosses being of cast steel, secured to the paddle shafts by steel pins. The floats are of American elm, the working pins of steel cased with gun-metal, and the arm bosses and radius rods bushed with lignum vitæ.

Steam is supplied by an ordinary marine cylindrical boiler of the return-tube type, 9 ft. diameter by 8 ft. 9 in. long, having 700 sq. ft. of heating surface and 25 sq. ft. of fire-grate area; Howden's system of forced draft being applied, with a special spark arrester uptake. An independent fan and engine are placed in the stokehold for the supply of air to the furnaces through the Howden apparatus, which delivers it to the fires considerably raised in temperature. For the ready handling of the main engine a Brown's steam starting engine is fitted—seen in illustration on the port side of the plan—having a by-pass valve to the low-pressure cylinder receiver. A silent blow-off to the condenser is also fitted to carry off any steam that may have accumulated during brief stoppages at the river piers. The engine-room equipment also includes a steam steering engine, an electric light engine and dynamo, an auxiliary feed engine, and a large reserve feed-water tank.

BRITISH ADMIRALTY CHARTS

Following is the by-monthly list of new charts and corrections of the British admiralty handled by J. D. Potter, admiralty chart agent, 145 Minories, London:

No.

x 15 Diagram to facilitate the obtaining a ship's position by Sumner's method.
3230 to 3250 Monthly wind charts for the South Atlantic ocean; twelve charts bound together in an atlas.
3427 France, north coast:—Rade de Brest.
3383 Nova Scotia:—The Gut of Canso.
3450 West Indies. Cuba, south coast:—Ensenada de Mora.
3454 Central America:—Plans of anchorages on the north coast of Panama.
3447 British Columbia. Vancouver island, east coast:—Moresby passage with its approaches.
3448 North America, west coast. Queen Charlotte sound:—Blunden harbor.
3430 North America. Vancouver's island:—Galetas and New channels.
3443 North America. Vancouver's island:—Nawhitti bar. Bull harbor.
3452 Persian gulf entrance:—Khor Kawi anchorage.
3456 Bay of Bengal, east coast:—Cox's Bazar.
3453 Malacca strait:—Klang strait and approaches.
3368 Philippine islands. South part of Luzon island:—Batan I. to San Bernardino I., and Himagaan bay to Inamok.
3450 China, southeast coast. Hong hai bay:—Sam chau inlet.
130 Japan. Ikitsuki jima to Taka shima, including the northern approaches to Hirado kaikyo.
3438 Japan:—O shima to Furubira wan.
3409 Japan. Ishinomaki wan (Sendai bay) and Sakata ko to Tsugaru kaikyo (strait).
3439 Solomon islands, Ysabel:—Austria sound (Plan:—Allardyce harbor).
3445 Pacific ocean. Loyalty islands:—Uvea atoll and Beautemps-Beaupre island.
1751 Rio de la Plata. Sauce point to Martin Garcia island. Plan added:—Sauce harbor.
1881 Indian ocean. Cargados Carajos islands. Plan added:—Agalega islands.
3031 Bays and anchorages on the east coast of Borneo. New plan:—Buja and Manimbora anchorages.
1384 Pacific ocean. Loyalty islands, anchorages in. Plans added:—Dokin bay. Gaatcha bay. Ro bay. Poane bay. Aui bay.

ADDITIONS OR CORRECTIONS.

1188 The World. Coal and telegraph chart.
2213 England, south coast. Teignmouth.
1776 Færoe islands:—Trangjisvaag.
3159 Norway. Torbiornskier to Jœloen.
3160 Norway. Torbiornskier to Rauo.
2300 Baltic. Gulf of Bothnia. Sheet V.:—Stierno point to Fiaderag, etc.
2302 Baltic sea. Sheet VII. Tome point round the head of the gulf to Tauvo.
3345 France, west coast:—Chenal du Four.
274 North Polar chart. Atlantic side.
278 North Polar chart. Pacific side.
2740 Iceland and the Færoe islands.
2976 Iceland:—Snefells Jokel to North cape.
2977 Iceland. North cape to Sigle fiord.
275 America, north coast. Smith sound, Kennedy and Robeson channels.
2564 United States America, east coast:—Delaware river. (Sheet 2.)
528 South America. Sheet IV. Maranham to Pernambuco.
1911 United States, west coast. Approach to Juan de Fuca strait.
2998 Africa, south coast. Port Natal entrance.
2757 Banka strait to Singapore.
941*a* Eastern archipelago, western portion.
941*b* Eastern archipelago, western portion.
2637 Celebes. Strait of Makassar, south part.
1466 China, east coast. Hongkong. Fotaumun pass.
2409 West coast of Formosa and Pescadores channel.

Charts that have received additions or corrections too large to be conveniently inserted by hand, and in most cases other than those referred to in the Admiralty Notices to Mariners:

913 Korea, west coast:—Mackau group to Clifford islands.
104 Korean archipelago, southern portion.
3365 Korea, southwest coast:—Port Hamilton to Mackau group.
980 Caroline islands.

WORDS OF COMMENDATION

Editor Marine Review: Enclosed please find P. O. money order for $3.00 being my subscription to Marine Review for the year 1906. I am very well pleased with your paper and your sentiments in regard to merchant marine are in line with my own. I was very much interested in the trip the Merchant Marine Commission took around the country and the speeches were all interesting reading. Yours for success in the rebuilding of the United States merchant marine, I am

F. B. WHITAKER,
Naval Constructor's office,
Seattle, Wash care of Moran Bros. Co.

Supt. A. A. Schantz, of the Detroit & Cleveland and Detroit & Buffalo lines, has announced several decided changes in the schedules of the boats for the coming season. For the first time in the history of the line, day trips will be made on Sundays between Detroit and Cleveland and the day trips will be withdrawn on Mondays during June, July and August. Monday will be devoted to boiler cleaning and repairs. The week end excursion rates will apply to passengers leaving either terminal Sunday morning and returning from the other end Sunday night. The boats between Detroit and Buffalo will be put on fourteen and one-half hour schedules instead of fourteen, as heretofore.

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MARINE REVIEW

VOL. XXXI. CLEVELAND, O., MARCH 2, 1905. No 9.

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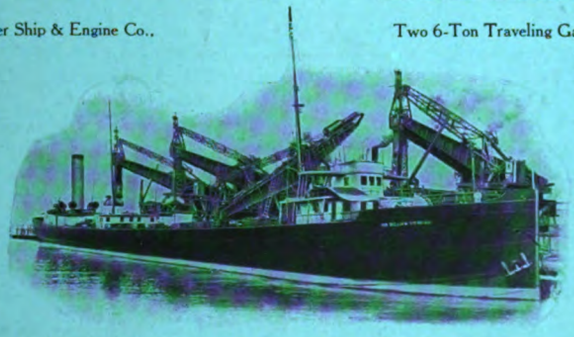

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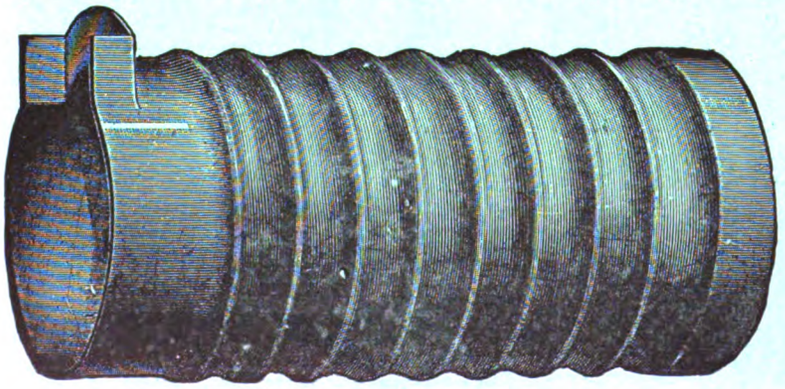

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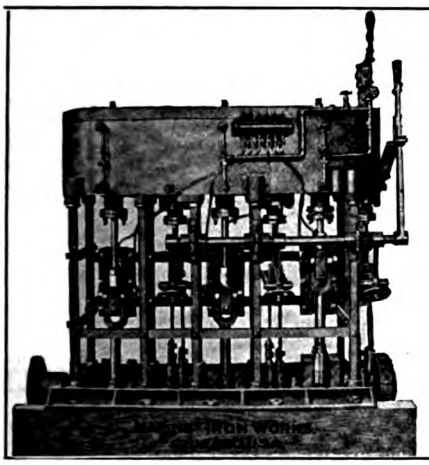

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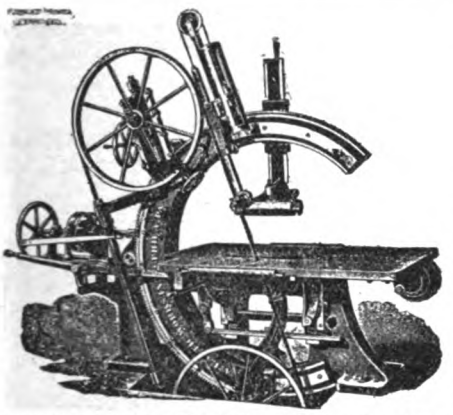

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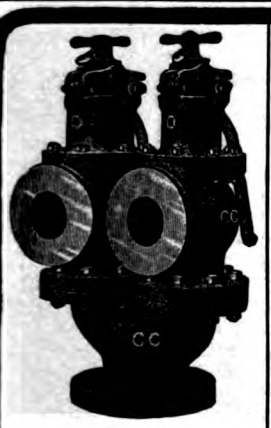

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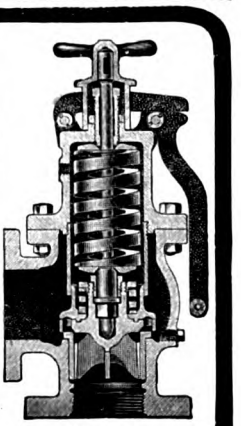

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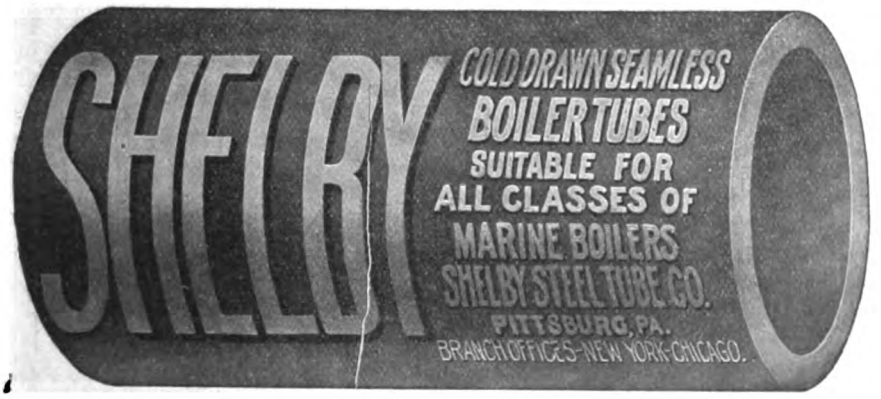

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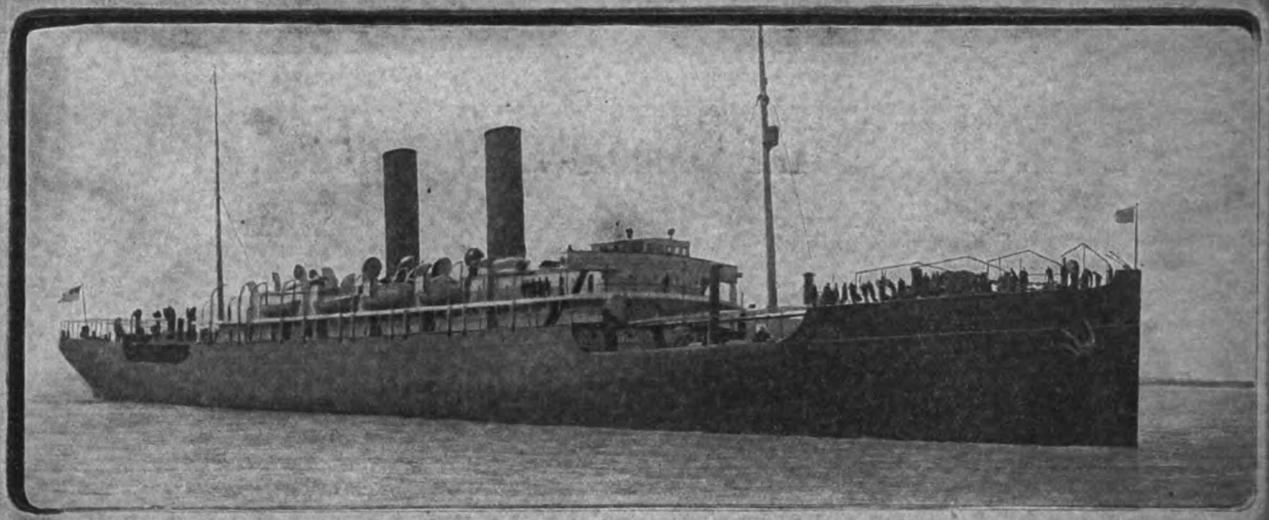

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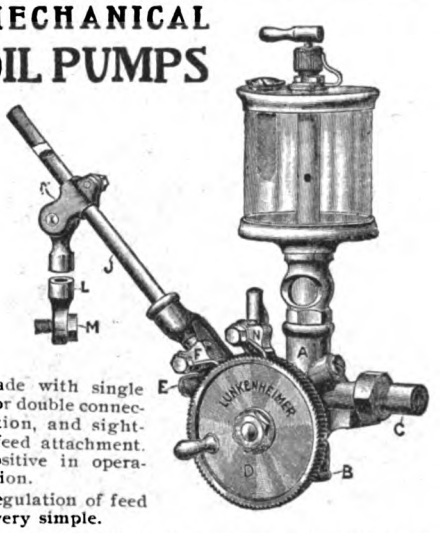

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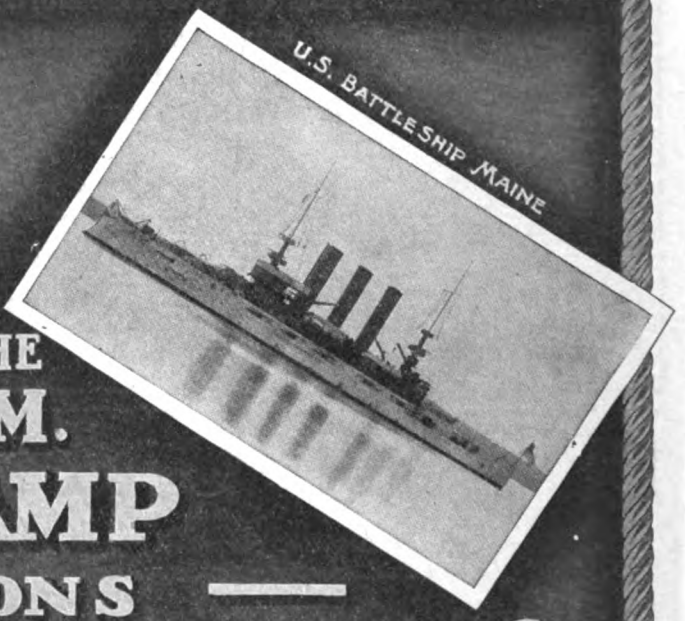

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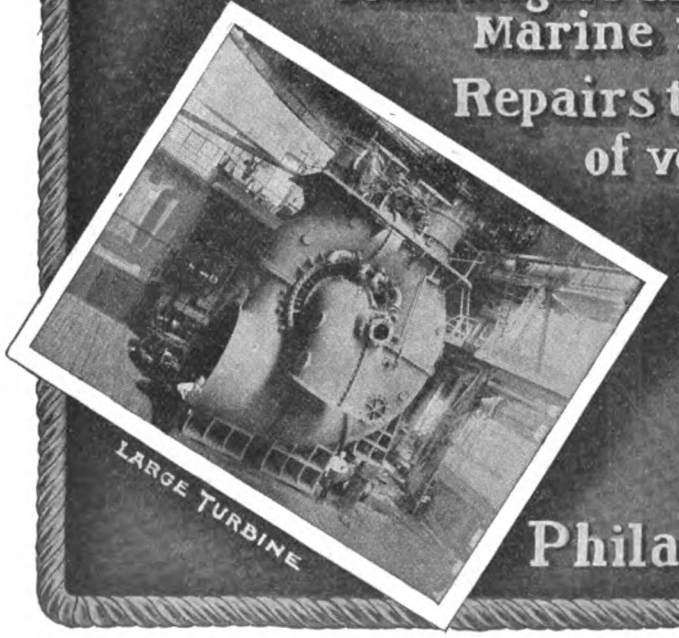

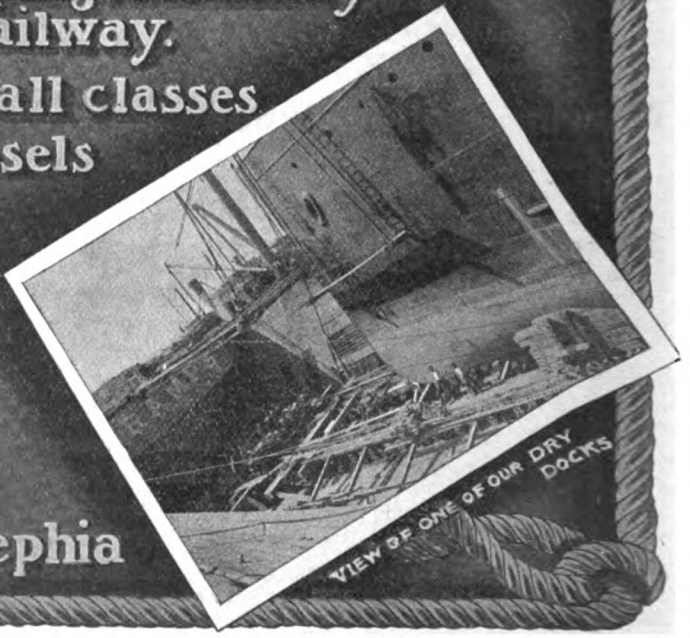

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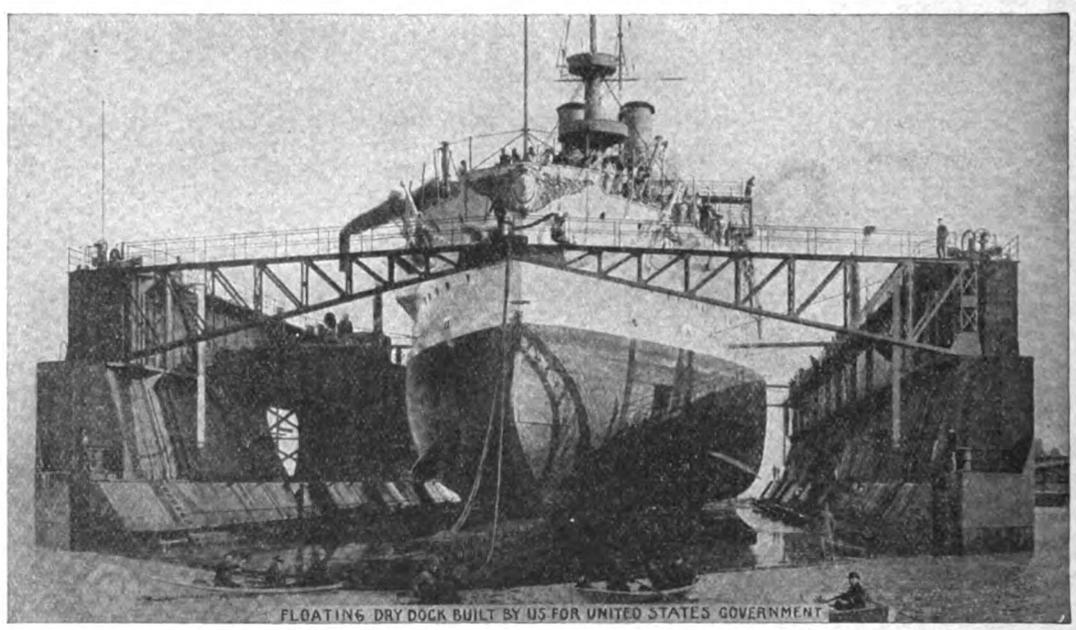

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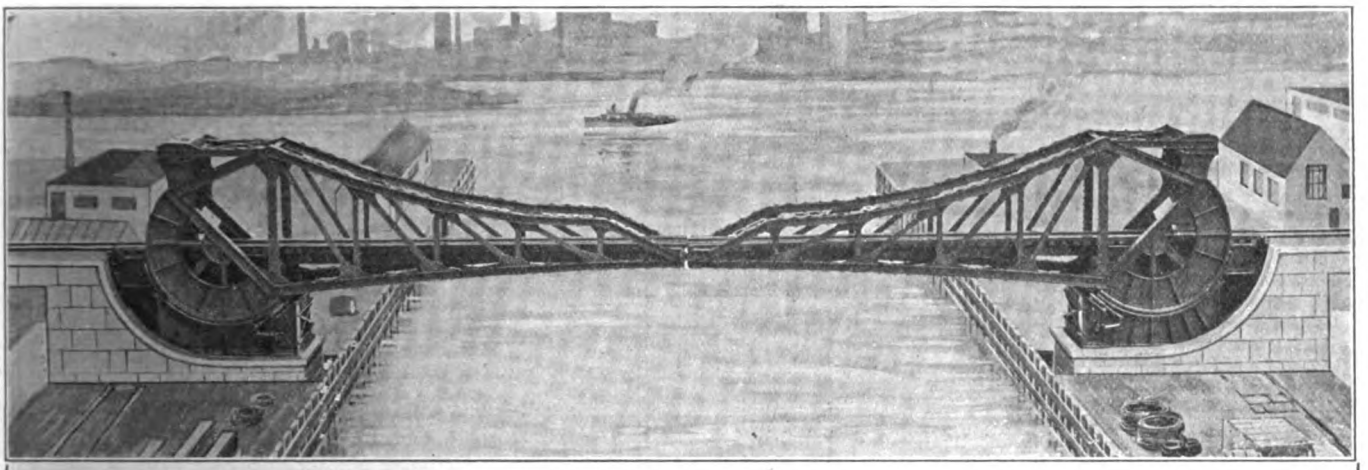

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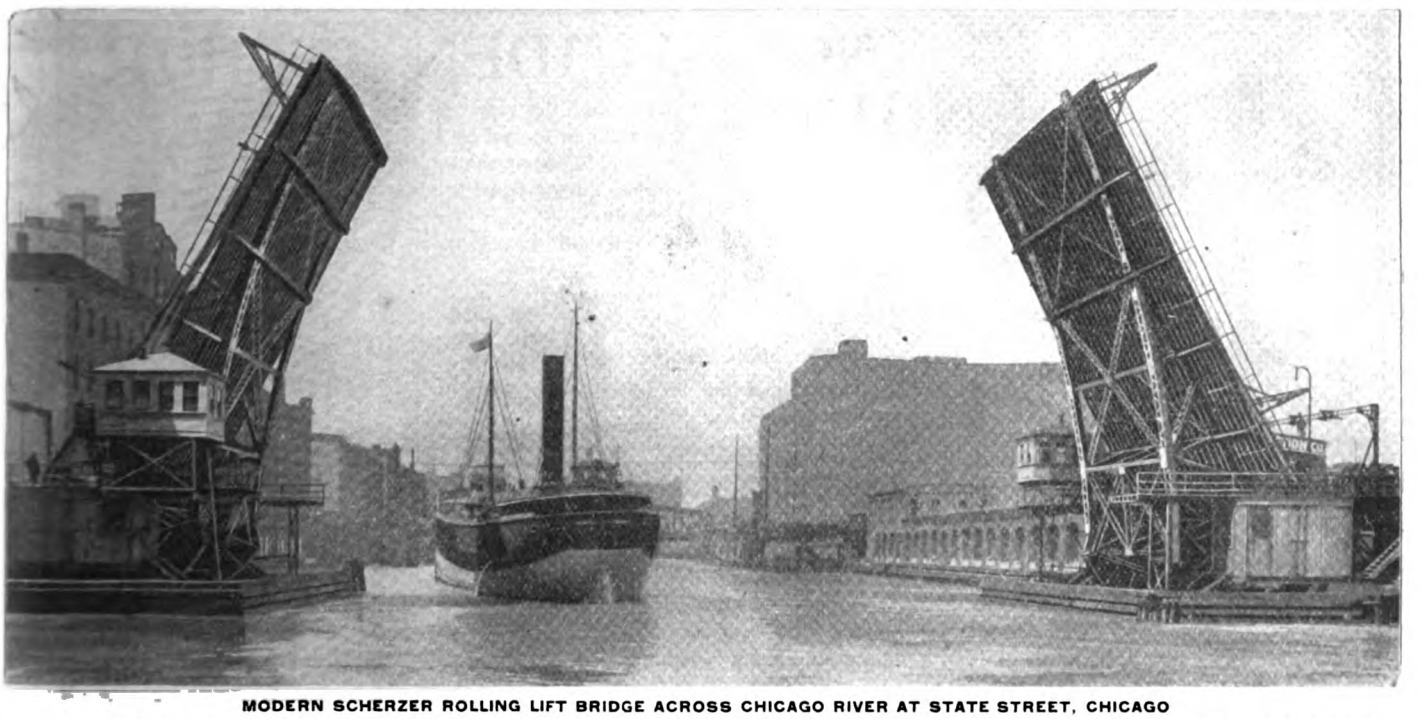

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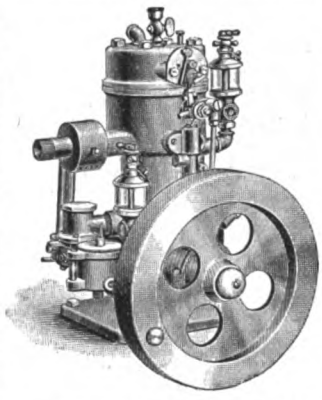

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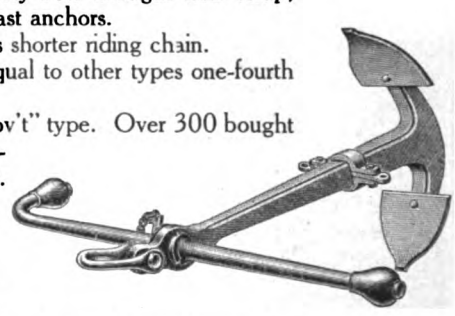

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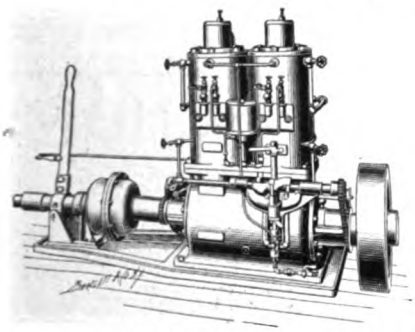

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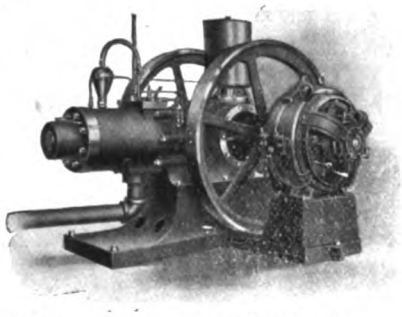

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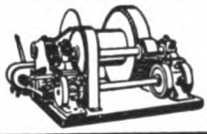

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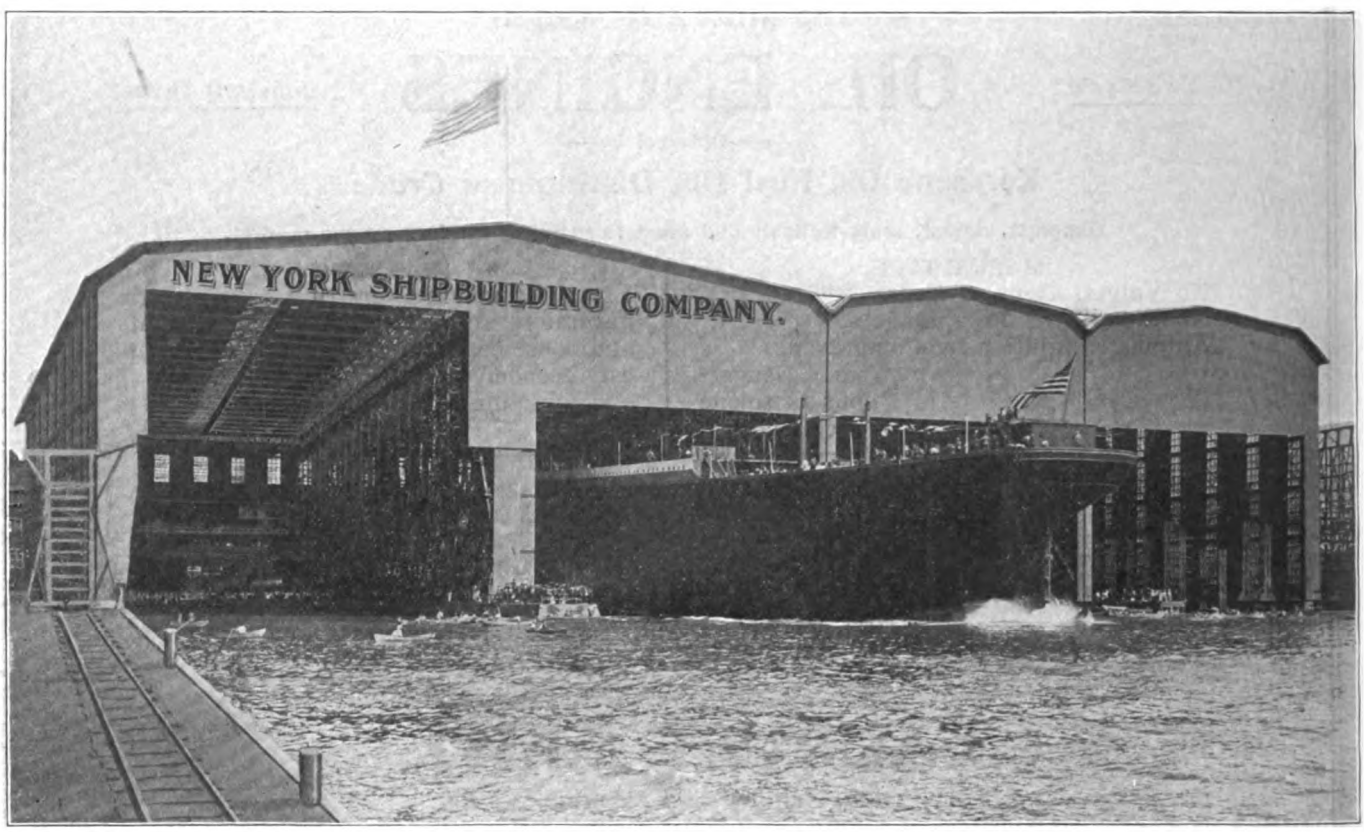

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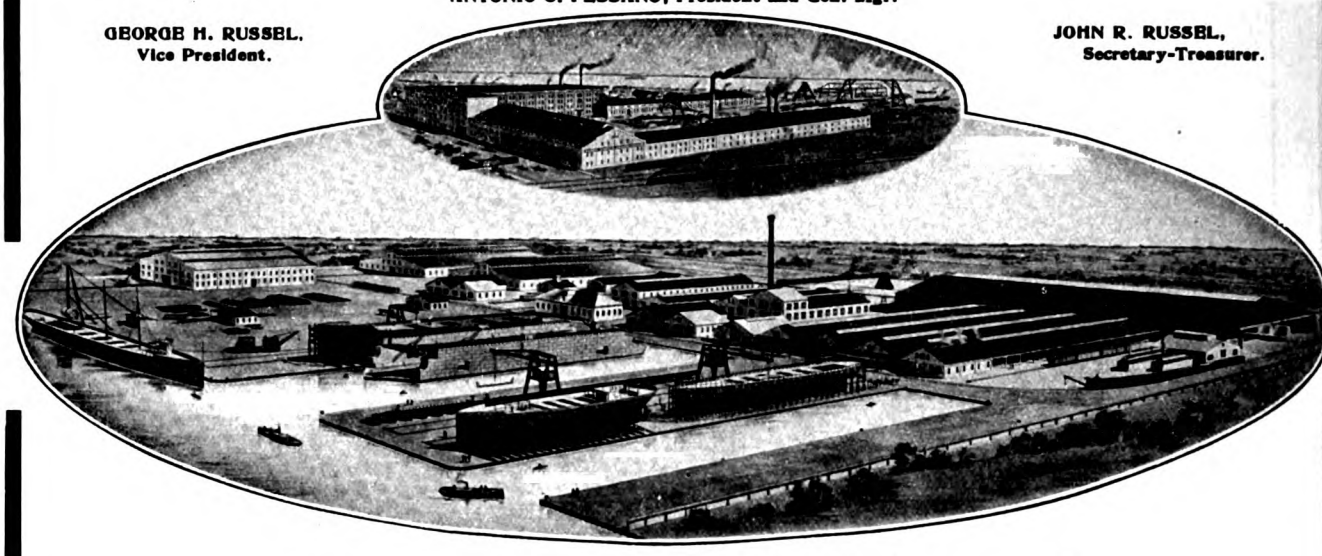

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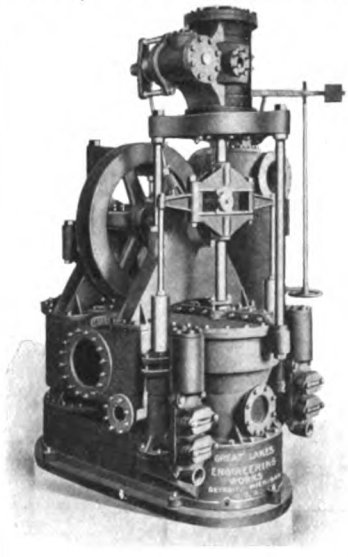

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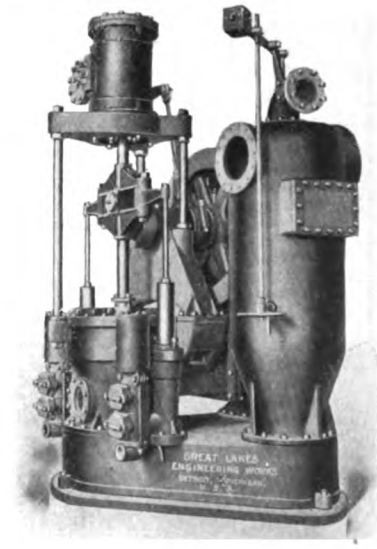

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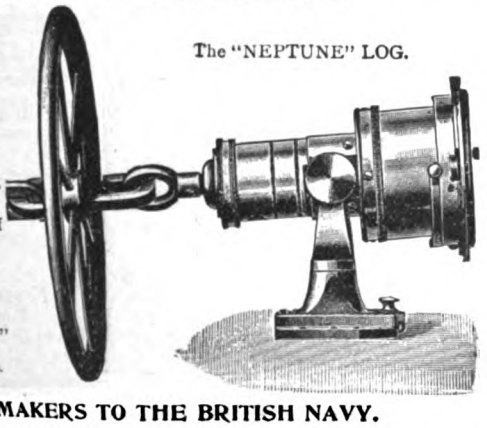

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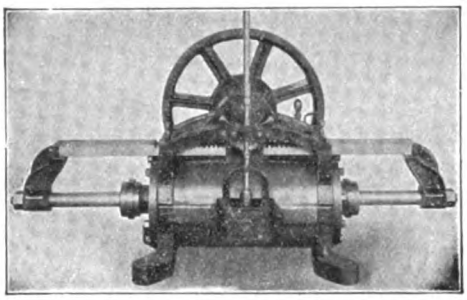

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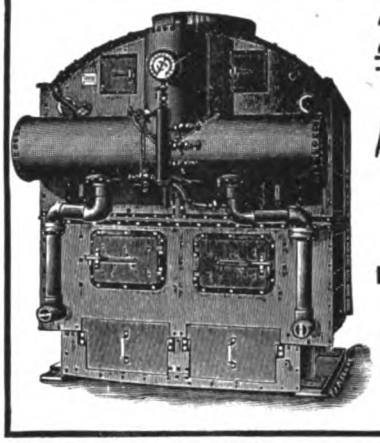

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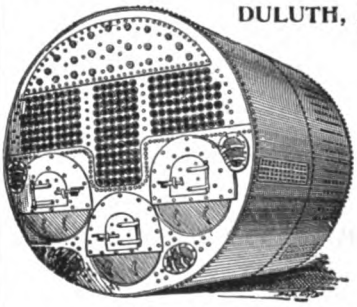

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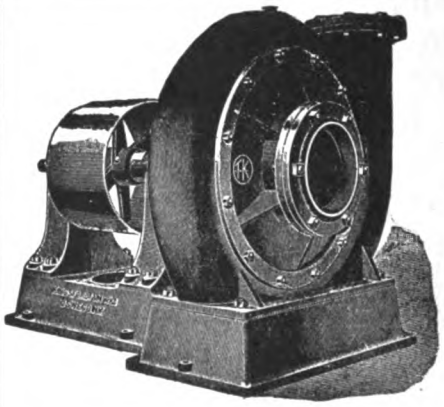

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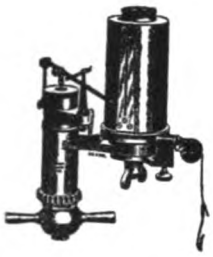

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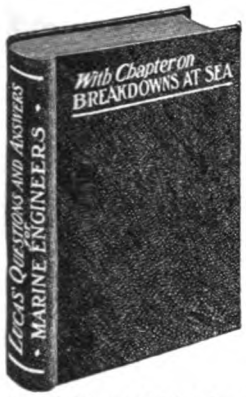

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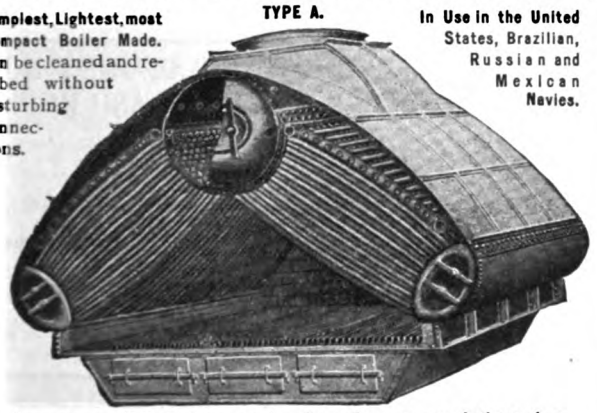

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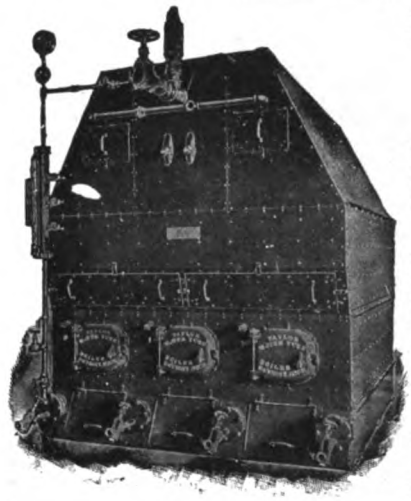

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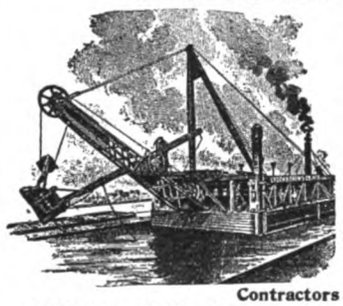

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PROPOSALS FOR DREDGE.—Mississipp River Commission, Fullerton Building, St. Louis, Mo., Jan. 16, 1905.—Sealed proposals, in triplicate, for construction and delivery of self-propelling hydraulic dredge and ponton pipe line will be received here until 12 noon, standard time, March 17, 1905, and then publicly opened. Information furnished on application. WM. B. LADUE, Capt., Eng'rs, Sec'y. Mar. 9

U. S. ENGINEER OFFICE, Jones Building, Detroit, Mich., Feb. 6, 1905. Sealed proposals for hire of dredging plant for use in Lake St. Clair will be received at this office until 2 p. m. (standard time) March 8, 1905, and then publicly opened. Information furnished on application. Chas E. L. B. Davis, Lieut. Col., Eng'rs. Mar. 2

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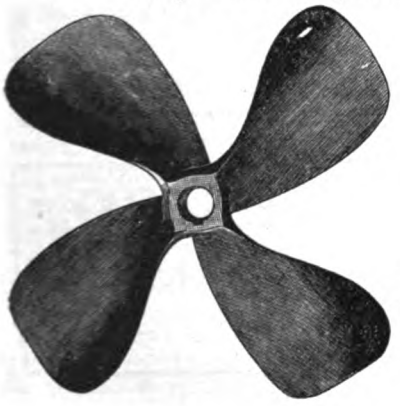

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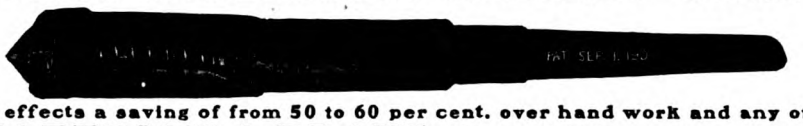

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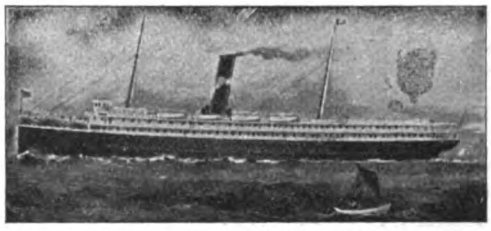

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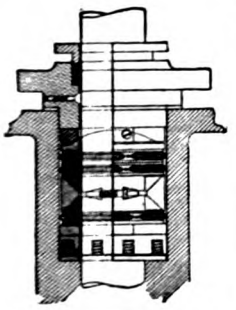

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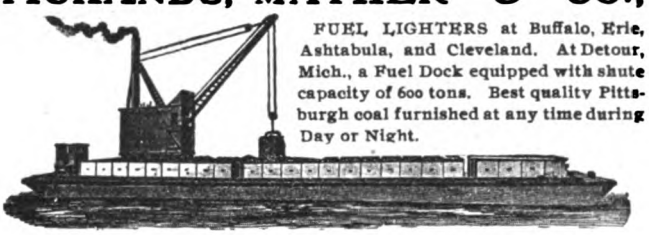

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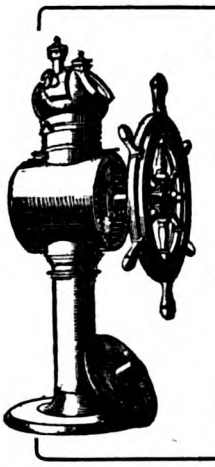

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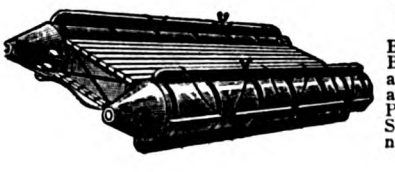

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..... Boston.
Ashton Valve Co.....Boston.
Crane Co. .....Chicago.
Lunkenheimer Co. .....Cincinnati.

SAIL MAKERS.
American Canvas & Tarpaulin Corp ....Buffalo.
Baker, Howard H. & Co.....Buffalo.
Upson-Walton Co.....Cleveland.

SALVAGE COMPANIES.
See Wrecking Companies.

SEARCH LIGHTS.
General Electric Co.....Schenectady, N. Y.
Westinghouse Electric & Mfg. Co.....
.....Pittsburg, Pa.

SHEARS.
See Punches, Rivets, and Shears.

SHIP AND BOILER PLATES AND SHAPES.
Bourne-Fuller Co.....Cleveland, O.
Otis Steel Co.....Cleveland.
Reading Iron Co.....Reading, Pa.

SHIP BUILDERS.
American Ship Building Co.....Cleveland.
Atlantic Works .....East Boston, Mass.
Bertram Engine Works Co., Ltd.Toronto, Can.
Buffalo Dry Dock Co.....Buffalo.
Cramp, Wm. & Sons.....Philadelphia.
Craig Ship Building Co.....Toledo, O.
Chicago Ship Building Co.....Chicago.
Detroit Ship Building Co.....Detroit.
Fore River Shipbuilding Co.....Quincy, Mass.
Great Lakes Engineering Works.....Detroit.
Lockwood Mfg. Co.....East Boston, Mass.
Maryland Steel Co.....Sparrows Point, Md.
Milwaukee Dry Dock Co.....Milwaukee.
Newport News Ship Building Co.....
.....Newport News, Va.
New York Shipbuilding Co.....Camden, N. J.
Roach's Ship Yard .....Chester, Pa.
Shipowner's Dry Dock Co.....Chicago.
Smith & Son, Abram.....Algonac, Mich.
Willard, Chas. P. & Co.Winthrop Harbor, Ill.

SHIP CHANDLERS.
American Canvas & Tarpaulin Corp ....Buffalo.
Baker, Howard H. & Co.. .....Buffalo.
Marine Mfg. & Supply Co.....New York.
Upson-Walton Co.....Cleveland.

SHIP DESIGNERS.
Kidd, Joseph.....Duluth
Kreer & Parsons. .....Chicago
Matteson & Drake .....Buffalo
Rice & Lovejoy.....Buffalo
Steel, Nacey & Hynd.....Cleveland
Wood, W. J.....Chicago

SHIP LANTERNS AND LAMPS.
Russell & Watson .....Buffalo.

SHIP TIMBER.
Martin-Barriss Co.....Cleveland.

SMOOTH-ON COMPOUND, FOR REPAIRS.
Smooth-On Mfg. Co.....Jersey City, N. J.

STAYBOLTS, IRON OR STEEL, HOLLOW OR SOLID.
Falls Hollow Staybolt Co..Cuyahoga Falls, O.
Reading Iron Co.....Reading, Pa.

STEAM VESSELS FOR SALE.
Gilchrist & Co., C. P. .....Cleveland.
Holmes, Samuel .....New York.
Lester, S. S.....Quebec, Can.
McCarthy, T. R.....Montreal, Can.

STEAMSHIP LINES, PASS. AND FREIGHT.
American Line .....New York.
Anchor Line .....Buffalo.
Boston Steamship Co .....Boston.
International Mercantile Marine Co.....
..... Philadelphia.
New York & Cuba Mail S. S. Co.....New York
Red Star Line .....New York.
United Fruit Co .....Boston.

STEEL CASTINGS.
Otis Steel Co.....Cleveland.

STEERING APPARATUS.
American Ship Building Co.....Cleveland.
Chase Machine Co.....Cleveland.
Detroit Ship Building Co.....Detroit.
Hyde Windlass Co.....Bath, Me.
Marine Mfg. & Supply Co.....New York.
Moulton Steering Engine Co.....New York.
Sheriffs Mfg. Co.....Milwaukee.

SUBMARINE DIVING APPARATUS.
Morse & Son, A. J.....Boston.
Schrader's Son, A.....New York.

SURVEYORS, MARINE.
Gaskin, Edward .....Buffalo.
Hynd, Alexander .....Cleveland.
Lovejoy, H. O.....Buffalo.
Matteson & Drake .....Philadelphia.
Parker Bros. Co., Ltd.....Detroit.
Nacey, James .....Cleveland.
Rice, Henry .....Buffalo.
Steel, Adam .....Cleveland.
Wood, W. J.....Chicago.

TARPAULINS.
American Canvas & Tarpaulin Corp ....Buffalo.

TESTS OF MATERIALS.
Hunt, Robert W. & Co.....Chicago.
Lunkenheimer Co .....Cincinnati, O

TILING, INTERLOCKING RUBBER.
New York Belting & Packing Co...New York.

TOOLS, METAL WORKING, FOR SHIP AND ENGINE WORKS.
Watson-Stillman Co.....New York.

TOOLS, WOOD WORKING.
Atlantic Works, Inc.....Philadelphia.

TOWING MACHINES.
American Ship Windlass Co..Providence, R. I.
Chase Machine Co.....Cleveland.

TOWING COMPANIES.
Donnelly Salvage & Wrecking Co.....
.....Kingston, Ont.

TRAPS, STEAM.
Kieley & Mueller .....New York.
Sturtevant Co., B. F., ...Hyde Park, Mass.

TRUCKS.
Boston & Lockport Block Co.....Boston.

TUBING, SEAMLESS.
Shelby Steel Tube Co.....Pittsburg, Pa.

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American Steam Gauge & Valve Mfg. Co. ..... Boston.
Ashton Valve Co. ..... Boston.
Crane Co. ..... Chicago.
Jenkins Bros. ..... New York.
Kieley & Mueller ..... New York.
Lunkenheimer Co. ..... Cincinnati.
Ross Valve Co. ..... Troy, N. Y.

VALVES FOR WATER AND GAS.
Lunkenheimer Co. ..... Cincinnati.
Ross Valve Co. ..... Troy, N. Y.

VARNISHES.
Detroit Varnish Co. ..... Detroit.
Detroit White Lead Works ..... Detroit.
New Jersey Zinc Co. ..... New York.
Also Ship Chandlers.

VENTILATING APPARATUS FOR SHIPS.
Sturtevant, B. F. Co. ..... Hyde Park, Mass.

VESSEL AND FREIGHT AGENTS.
Boland, John J. ..... Buffalo.
Brown & Co. ..... Buffalo.
Elphicke, C. W. & Co. ..... Chicago.
Fleming & Co., E. J. ..... Chicago.
Gilchrist & Co., C. P. ..... Cleveland.
Hall, John B ..... Buffalo.
Helm & Co., D. T. ..... Duluth.

VESSEL AND FREIGHT AGENTS—Con.
Hawgood & Co., W. A. ..... Cleveland.
Holmes, Samuel ..... New York.
Hutchinson & Co. ..... Cleveland.
Lester, S. S. ..... Quebec, Can.
McCarthy, T. R. ..... Montreal.
Mitchell & Co. ..... Cleveland.
Parker Bros. Co., Ltd. ..... Detroit.
Prindiville & Co. ..... Chicago.
Richardson, W. C. ..... Cleveland.
Sullivan, D. & Co. ..... Chicago.

WATER GAUGES.
Bonner & Co., Wm. T. ..... Boston
Lunkenheimer Co. ..... Cincinnati, O.

WATERTIGHT BULKHEAD DOORS.
"Long Arm" System Co ..... Cleveland.

WIRE ROPE AND WIRE ROPE FITTINGS.
Baker, H. H. & Co. ..... Buffalo.
DeGrauw, Aymar & Co. ..... New York.
Upson-Walton Co. ..... Cleveland.

WHISTLES, STEAM.
American Steam Gauge & Valve Mfg. Co. ..... Boston.
Ashton Valve Co. ..... Boston.
Lunkenheimer Co. ..... Cincinnati.

WINDLASSES.
American Ship Windlass Co. . Providence, R. I.
American Ship Building Co. ..... Cleveland.
Hyde Windlass Co. ..... Bath, Me.
Marine Mfg. & Supply Co. ..... New York.

WINCHES.
American Ship Windlass Co. . Providence, R. I.
Georgian Bay Engineering Works. ..... Midland, Ont.
Hyde Windlass Co. ..... Bath, Me.

WOOD PRESERVING PAINT.
Carbolineum Wood Preserving Co. ... Milwaukee.

WOOD WORKING MACHINERY.
Atlantic Works, Inc. ..... Philadelphia.

WRECKING AND SALVAGE COMPANIES.
Donnelly Salvage & Wrecking Co. ..... Kingston, Ont.
Parker Bros. Co., Ltd. ..... Detroit.

YACHT AND BOAT BUILDERS.
Bertram Engine Works Co., Ltd. . Toronto, Can.
Drein, Thos. & Son ..... Wilmington, Del.
Georgian Bay Engineering Works. ..... Midland, Ont.
Truscott Boat Mfg. Co. ..... St. Joseph, Mich.
Willard, Chas. P. & Co Winthrop Harbor, Ill.

YAWLS.
Drein, Thos. & Son ..... Wilmington, Del.

ALPHABETICAL INDEX OF ADVERTISERS IN THE MARINE REVIEW.

The star (*) indicates that the advertisement appears alternate weeks. For addresses see advertisements on pages noted.
The dagger (†) indicates that advertisement appears once a month.

Almy Water Tube Boiler Co 40
American Bureau of Shipping ... 42
American Canvas & Tarpaulin Corp. 43
American Injector Co 3
American Line 43
American Ship Building Co 5
American Ship Windlass Co 2
American Steam Gauge Co 41
Armstrong Cork Co 56
Ashton Valve Co 39
Atlantic Works 46
Atlantic Works, Inc. 3

Babcock & Wilcox Co 17
Baker, Howard H., & Co. 56
Bertram Engine Works Co. Ltd . 46
Blake, Geo. F., Mfg. Co 46
Boland, J. J 48
Bonner & Co., Wm. T 12
Boston & Lockport Block Co. ..... *
Boston Steamship Co. 43
Bourne-Fuller Co. 39
Bowers, L. M., & Co 40
Brevmann & Bros., G. H 44
Brown Hoisting Machinery Co. Inc 2
Buffalo Dredging Co. 44
Buffalo Dry Dock Co 4

Camden Anchor-Rockland Machine Co 12
Carbolineum Wood Preserving Co. 42
Chase Machine Co. 13
Chicago & Gt. L. Dredge & Dock Co 44
Chicago Ship Building Co 4
Cleveland City Forge & Iron Co . 54
Continental Iron Works 2
Cowing, John P. 11
Cory, Chas. & Son 54
Craig Ship Building Co. ..... *
Cramp, Wm. & Sons, S. & E. B. Co 8
Crandall & Son, H. I. ..... *
Crane Co. 5-41-42

Dearborn Drug & Chemical Wks.. 13
Dearing Water Tube Boiler Co. 15
DeGrauw, Aymar & Co 83
Delaunay, Belleville & Co 39
Delaware River Iron S. B. & E. Works 46
Detroit Ship Building Co. 5
Dixon Crucible Co., Joseph 54
Donnelly Salvage & Wrecking Co 42
Drein, Thos., & Son 47
Dunbar & Sullivan Dredging Co. 44

Elphicke, C. W., & Co. 48

Falls Hollow Staybolt Co. 40
Fitz-Simons & Connell Co 44
Fix's, S., Sons 54
Fleming & Co., E. J 48
Fletcher, W. & A., Co 46
Fogg, M. W 2
Fore River Shipbuilding Co. 46

General Electric Co. 56
Georgian Bay Engineering Wks.. 46
Gilchrist, Albert J 48
Gilchrist & Co., C. P 48
Goulder, Holding & Masten 48
Great Lakes Engineering Works 16
Great Lakes Register 42

Hall, John B. 48
Hanna, M. A., & Co. 47
Hawgood & Co., W. A 48
Helm & Co., D. T 48
Hickler Bros 44
Holmes, Samuel 48
Holzapfel's American Compositions Co. 40
Hoyt, Dustin & Kelley 76
Hunt, Robert W., & Co. 77
Hutchinson & Co 76
Hyde Windlass Co 56

International Mercantile Marine Co. 43

Jenkins Brothers 56

Kahnweiler's Sons, David 54
Katzenstein, L., & Co. 47
Kidd, Joseph 49
Kieley & Mueller 39
Kingsford Foundry & Machine Works 40
Kreer & Parsons. 49
Kremer, C. E 48

Lake Superior Contracting & Dredging Co. 44
Lebanon Chain Works 54
Le Mois Scientifique et Industrial 46
Lester, S. S 48
Lockwood Mfg. Co 46
Long-Arm System Co. 45
L. S. & M. S. Ry. 55
Lunkenheimer Co. 7

McCarthy, T. R 48
McCurdy, Geo. L 42
McMyler Mfg. Co ..... *
MacDonald, Ray G 48
Marine Iron Co., Bay City, Mich. 47
Marine Iron Works. 3
Marine Mfg. & Supply Co. 47
Martin-Barriss Co 41
Maryland Steel Co 10
Matteson & Drake 46
Mietz, Aug 43
Milwaukee Dry Dock Co 4
Mitchell & Co 48
Morse & Son, A. J 54
Mosher Water-Tube Boiler Co ... 41
Moulton Steering Engine Co 40

Nacey & Hynd 49
Newport News Ship Building & Dry Dock Co 6
New York & Cuba Mail S. S. Co.. 43
New York Shipbuilding Co. 14
Northwestern Steam Boiler & Mfg. Co 40

Otis Steel Co 9

Parker Bros. Co 48
Peck, Chas. E. & W. F 42
Penberthy Injector Co ..... *
Perfection Broom Co. 55
Pickands, Mather & Co 47
Pittsburg Coal Co 9
Potter & Potter 48
Potter, J. D 40
Powell, Ambrose V 49
Power Specialty Co. ..... *
Prindiville & Co 48

Reading Iron Co 7
Record of American & Foreign Shipping 42
Red Star Line 43
Reliance Mfg. Co. 47
Rice, Henry, and Lovejoy, H. O... 49
Richardson, W. C 48
Ritchie & Sons, E. S. ..... *
Roberts Safety Water-Tube Boiler Co. 49
Roelker, H. B. 46
Ross Valve Co 54

Safety Car Heating & Lighting Co. 7
Scherzer Rolling Lift Bridge Co. 11-56
Schrader's Son, A 2
Shaw, Warren, Cady & Oakes... 48
Shelby Steel Tube Co. 5
Sheriffs Mfg. Co 45
Shipowners' Dry Dock Co 46
Shipping World 49
Smith & Son, Abram ..... *
Smith Co., L. P. & J. A. 44
Smith Coal & Dock Co., Stanley B 9
Smith, Stanley B., & Co 9
Smooth-On Mfg. Co 40
Standard Oil Co ..... *
Starke Dredge & Dock Co., C. H.. 47
Stirling Co. 9
Stratford Oakum Co., Geo 2
Sturtevant, B. F., Co 56
Sullivan, M. 47
Sullivan & Co 48
Superior Ship Building Co 4

Taylor Water-Tube Boiler Co ... 41
Thropp, J. E., & Sons Co 54
Trout, H. G 45
Truscott Boat Mfg. Co. 55

United Fruit Co. 43
Upson-Walton Co. 56

Walker, Thomas, & Son 39
Ward Line 43
Watson-Stillman Co 55
Westinghouse Electric & Mfg. Co. 41
White, Johnson, McCaslin & Cannon 48
Willard, Chas. P., & Co. 47
Wood, W. J 49
Woodhouse Chain Works 3

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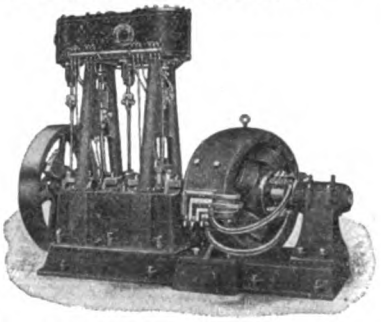

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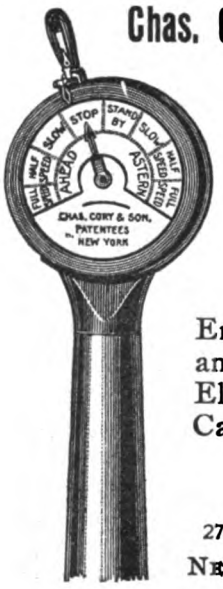

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Eastward	Arrive from West	Depart East
No. 18, Southwestern Limited	.....	*1:50 a.m.
No. 22, Lake Shore Limited	*2:12 a.m.	*2:20 a.m.
No. 20, Chicago and Cleveland Exp.	*7:20 a.m.	.....
No. 28, New York and Boston Exp.	*7:40 a.m.	*8:00 a.m.
No. 40, Toledo and Buffalo Accom	†10:00 a.m.	†10:30 a.m.
No. 32, Fast Mail	*11:25 a.m.	*11:30 a.m.
No. 48, Accommodation via Sandusky	†1:40 p.m.	.....
No. 42, Boston-New York Express	.....	*11:45 a.m.
No. 44, Cleveland and New York Spl.	.....	*3:00 p.m.
No. 46, Southwestern Express	.....	*3:10 p.m.
No. 116, Ashtabula Accommodation	.....	†4:30 p.m.
No. 6, Limited Fast Mail	*5:40 p.m.	*5:45 p.m.
No. 26, 20th Century Limited	*7:40 p.m.	*7:43 p.m.
No. 10, Chicago, N.Y. & Boston Spl.	*7:30 p.m.	*7:50 p.m.
No. 16, New England Express	*10:30 p.m.	*10:35 p.m.
No. 2, Day Express	†9:10 p.m.	†9:25 p.m.
No. 126, Norwalk Accommodation	†7:55 a.m.	.....

Westward	Arrive from East	Depart West
No. 7, Exposition Limited	*12:50 a.m.	.....
No. 11, Southwestern Limited	*2:55 a.m.	.....
No. 9, Day Express	.....	†6:00 a m.
No. 15, Boston and Chicago Special	*3:10 a.m.	*3:15 a.m.
No. 19, Lake Shore Limited	*7:15 a.m.	*7:25 a.m.
No. 23, Western Express	*10:30 a.m.	*10:35 a.m.
No. 29, Southwestern Special	‡11:10 a.m.	.....
No. 33, Southwestern Express	*12:25 p.m.	.....
No. 133, Cleveland and Detroit Exp.	.....	*12:45 p.m.
No. 47, Accommodation	†11:00 a.m.	†3:00 p m.
No. 141, Sandusky Accommodation	.....	†3:10 p.m.
No. 43, Fast Mail	*4:35 p.m.	*4:40 p.m.
No. 127, Norwalk Accommodation	.....	†5:10 p.m.
No. 37, Pacific Express	*6:50 p.m.	*7:20 p m.
No. 3, Fast Mail Limited	*10.50 p.m.	*10:55 p.m.
No 115, Ashtabula Accommodation	*8.30 a.m.	.....

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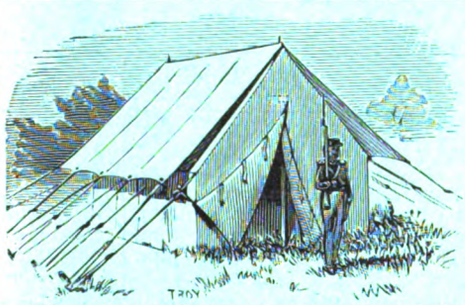

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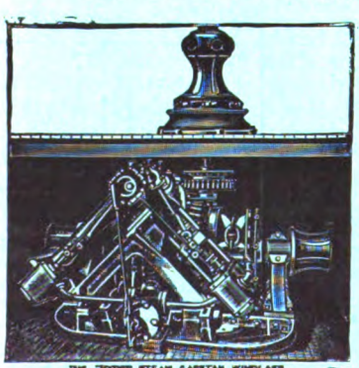

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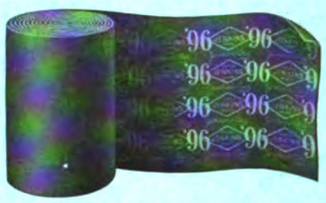

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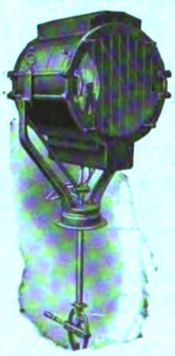

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